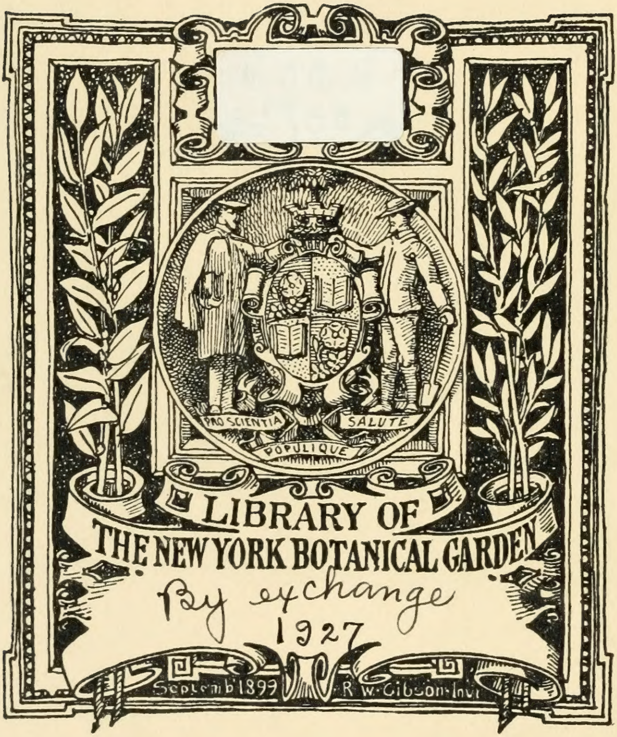

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FORTY-EIGHTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MICHIGAN

AND

TWENTY-SECOND ANNUAL REPORT

OF THE

EXPERIMENT STATION

FROM

JULY 1, 1908, TO JUNE 30, 1909.

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1909

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REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

AGRICULTURAL COLLEGE, *July 1, 1909.*

TO HON. FRED M. WARNER,

Governor of the State of Michigan:

SIR—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1909, with supplementary papers.

Very respectfully,

ADDISON M. BROWN,

Secretary of the State Board of Agriculture.

STATE BOARD OF AGRICULTURE.

	Term expires.
ROBERT D. GRAHAM, Grand Rapids President of the Board.	1911
WILLIAM H. WALLACE, Bay Port	1909
AARON P. BLISS, Saginaw	1909
*THOMAS F. MARSTON, Bay City	1911
WILLIAM J. OBERDORFFER, Stephenson	1911
ALFRED J. DOHERTY, Clare	1913
I. ROY WATERBURY, Highland Station	1913
**WILLIAM L. CARPENTER, Detroit.	
FRED M. WARNER, Governor of the State	*Ex-Officio.*
JONATHAN L. SNYDER, President of the College	*Ex-Officio.*
A. M. BROWN, East Lansing, Secretary.	
B. F. DAVIS, Lansing, Treasurer.	

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

Botany and Horticulture	W. J. Oberdorffer, I. R. Waterbury.
Buildings and College Property	A. P. Bliss, A. J. Doherty.
Chemical, Physical, Bacteriological and other Departments not otherwise provided for	A. P. Bliss, T. F. Marston.
Employees	Wm. H. Wallace, A. P. Bliss, J. L. Snyder.
English and Mathematics	I. R. Waterbury, T. F. Marston.
Experiment Station	W. J. Oberdorffer, A. P. Bliss.
Farm Management	T. F. Marston, A. J. Doherty.
Finance	A. J. Doherty, I. R. Waterbury.
Forestry	Wm. H. Wallace, A. P. Bliss.
Farmers' Institutes	T. F. Marston, A. J. Doherty.
Land Grant	W. J. Oberdorffer, Wm. H. Wallace.
Library	I. R. Waterbury, W. J. Oberdorffer.
Mechanical Department	I. R. Waterbury, Wm. H. Wallace.
Military and Athletic	T. F. Marston, Wm. H. Wallace.
Woman's Department	A. J. Doherty, T. F. Marston.

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* Resigned.
** Appointed to fill vacancy.

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STATE AGRICULTURAL COLLEGE.

(Under control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

Jonathan L. Snyder, A. M., Ph. D., LL. D., President; [a,b,c] Feb. 25, '96.

Wm. J. Beal, Ph. D., D. Sc., Professor of Botany; [a,b] July 9, '70; [c] Sept. 1, '02.

Frank S. Kedzie, M. S., Professor of Chemistry, [a] Sept. 15, '80; [b,c] Sept. 1, '02.

Levi R. Taft, M. S., Superintendent of Farmers' Institutes and State Inspector of Orchards and Nurseries; [a] Aug. 1, '88; [b,c] July 1, '02.

Herman K. Vedder, C. E., Professor of Mathematics and Civil Engineering; [a,b,c] Sept. 15, '91.

Walter B. Barrows, B. S., Professor of Zoology and Physiology, and Curator of the General Museum; [a,b,c] Feb. 15, '94.

Charles E. Marshall, Ph. D., Professor of Bacteriology; [a] July 20, '96; [b,c] Sept. 1, '02.

Joseph A. Jeffery, B. S., Professor of Agronomy and Soil Physics; [a] Sept. 1, '99; [b,c] Nov. 11, '02.

Maude Gilchrist, B. S., A. M., Dean of Home Economics; [a,b,c] Sept. 1, '01.

Addison M. Brown, A. B., Secretary of the College; [a,b,c] June 1, '02.

Robert S. Shaw, B. S. A., Dean of Agriculture; [a,b] Sept. 1, '02; [c] Jan. 15, '08.

Chester L. Brewer, B. S., Director of Physical Culture; [a,b,c] Sept. '03.

Arthur R. Sawyer, A. B., E. E., Professor of Physics and Electrical Engineering; [a,b,c] April 11, '04.

Capt. F. W. Fuger, U. S. A., Professor of Military Science and Tactics; [a,b,c] Sept. 1, '05.

Rufus H. Pettit, B. S. A., Professor of Entomology; [a] Jan. 1, '97; [b,c] Sept. 1, '06.

Thomas C. Blaisdell, Ph. D., Professor of English Literature and Modern Languages; [a,b,c] Sept. 1, '06.

Wilbur O. Hedrick, M. S., Professor of History and Political Economy; [a,b] Aug. 24, '91; [c] June 20, '06.

George W. Bissell, M. E., Dean of Engineering and Professor of Mechanical Engineering; [a,b,c] June 18, '07.

Leslie M. Hurt, D. V. M., Professor of Veterinary Science; [a,b,c] Sept. 4, '07.

J. Fred Baker, M. F., Professor of Forestry and Supervisor of Forest Reserve Lands; [a,b,c] Oct. 1, '07.

H. J. Eustace, B. S., Professor of Horticulture; [a,b,c] Aug. 15, '08.

Victor T. Wilson, M. E., Professor of Drawing and Design; [a,b,c] Sept. 1, '08.

Walter H. French, Professor of Agricultural Education, [a,b,c] July 1, '08.

Warren Babcock, B. S., Associate Professor of Mathematics; [a,b] June 30, '91; [c] Sept. 1, '05.

Chace Newman, Assistant Professor of Drawing; [a] Sept. 1, '97; [b,c] Sept. 1, '07.

Jesse J. Myers, B. S., Assistant Professor of Zoology; [a,b] Sept. 1, '01; [c] June 26, '07.

E. Sylvester King, Assistant Professor of English; [a] Jan. 1, '00; [b,c] Sept. 1, '02.

James B. Dandeno, A. M., Ph. D.; Assistant Professor of Botany; [a,b,c] Sept. 1, '02.

H. W. Norton, Jr., B. S., Assistant Professor of Animal Husbandry; [a] Sept. 1, '03; [b,c] Sept. 1, '08.

Carl Gunderson, A. M., Ph. D., Assistant Professor of Mathematics; [a,b] Sept. 1, '04; [c] May 7, '08.

Harry S. Reed, Assistant Professor of Chemistry, [a,b] May 2, '05; [c] Sept. 1, '07.

Samuel C. Hadden, B. S., Assistant Professor of Mathematics and Civil Engineering; [a,b] Sept. 1, '05; [c] May 7, '08.

E. H. Ryder, A. M., Assistant Professor of History and Political Economy; [a,b] Sept. 1, '05; [c] May 2, '07.

A. Crosby Anderson, B. S., Assistant Professor of Dairy Husbandry; [a] Sept. 1, '05; [b,c] Aug. 18, '08.

Joseph A. Polson, B. S., Assistant Professor Mechanical Engineering; [a,b] Sept. 1, '06; [c] May 7, '08.

F. Hobart Sanford, B. S., Assistant Professor of Forestry; [a,b] Dec. 1, '06; [c] May 1, '09.

J. G. Halpin, B. S., Assistant Professor of Poultry Husbandry; [a] July '06; [b,c] May '08.

Charles P. Halligan, B. S., Assistant Professor of Horticulture; [a,b] April 8, 07; [c] May 7, '08.

Otto Rahn, Ph. D., Assistant Professor of Bacteriology; [a] Sept. '07; [b,c] Sept. 1, '08.

Louis L. Appleyard, B. S., Assistant Professor of Mechanical Engineering; [a] May 2, '07; [b,c] Sept. 1, '08.

Thomas Gunson, Instructor in Horticulture and Superintendent of the Grounds; [a,b] April 1, '91; [c] Sept. 1, '05.

Caroline L. Holt, Instructor in Drawing; [a,b,c] Sept. 1, '98.

Louise Freyhofer, B. S., Instructor in Music; [a,b,c] Sept. 1, '02.

Albert E. Jones, A. B., Instructor in Mathematics; [a,b,c] Sept. 15, '03.

Norma L. Gilchrist, A. B., Instructor in English and German; [a,b,c] Sept. 1, '05.

E. N. Bates, B. S., Instructor in Electrical Engineering; [a,b,c] Sept. 1, '06.

Leslie J. Smith, B. S., Instructor in Farm Mechanics; [a,b,c] July 1, '06.

*Grace L. Chapman, Instructor in Physical Culture; [a,b,c] Sept. 1, '06.

Arthur J. Clark, A. B., Instructor in Chemistry, [a,b,c] Sept. 1, '06.

William E. Lawrence, B. S., Instructor in Botany; [a b c] Sept. 1, '06.
Wiley B. Wendt, B. C. E., Instructor in Mathematics; [a b c] Sept. 1, '06.
W. Lloyd Lodge, B. S., M. A., Instructor in Physics; [a b c] Oct. 1, '06.
Andy Anderson, Instructor in Blacksmithing; [a b c] Sept. 1, '06.
Charles W. Chapman, Instructor in Physics; [a b c] Jan. 1, '07.
Zae Northrup, Instructor in Bacteriology; [a b c] Sept. 1, '07.
*Frank W. Howe, B. S., A. B., Instructor in Farm Crops; [a b c] Aug. 1, '07.
Pearl MacDonald, M. A., Instructor in Domestic Science; [a b c] Sept. 1, '07.
August C. Mehrtens, M. E., Instructor in Mechanical Engineering; [a b c] Sept. 1, '07.
Orestes I. Gregg, B. S., Instructor in Horticulture; [a b c] Sept. 1, '07.
Mrs. Minnie Hendricks, A. M., Instructor in History and Economics; [a] Sept. 1, '07; [b c] Sept. 1, '08.
Wallace B. Liverance, B. S., Instructor in Dairying; [a b c] Sept. 1, '07.
Charles H. Harper, B. S., Instructor in Drawing; [a b c] Sept. 1, '07.
W. Rodney Cornell, B. S., Instructor in Mathematics; [a b c] Sept. 1, '07.
J. Terence McVey, C. E., Instructor in Civil Engineering; [a b c] Sept. 1, '07.
William A. Robinson, A. B., S. T. B., Instructor in English; [a b c] Sept. 1, '07.
John C. Paltridge, A. B., Instructor in English; [a b c] Jan. 1, '08.
Rose M. Taylor, A. B., Instructor in Botany; [a b c] Feb. 8, '08.
*P. M. Bauknight, A. B., Instructor in English; [a b c] Sept. 1, '08.
Arthur E. Fish, A. B., Instructor in English; [a b c] Sept. 1, '08.
Herman Hensel, A. B., Instructor in German and English; [a b c] Sept. 1, '08.
Helen Michaelides, Instructor in French and English; [a b c] Sept. 1, '08.
Charles R. Mann, A. M., Instructor in English; [a b c] Sept. 1, '08.
L. S. Fuller, B. S., Instructor in Mathematics; [a b c] Sept. 1, '08.
Walter E. Hawks, B. A., Instructor in Mathematics; [a b c] Sept. 1, '08.
Philip Rosenberg, B. S., Instructor in Mathematics; [a b c] Sept. 1, '08.
H. L. Slobin, B. A., Ph. D., Instructor in Mathematics; Sept. 1, '08.
Curt H. Eiffert, B. S., Instructor in Drawing; [a b c] Sept. 1, '08.
**Isabel Pearl Snelgrove, Instructor in Drawing; [a b c] Sept. 1, '08.
Geo. A. Brown, B. S., Instructor in Animal Husbandry; [a b c] Sept. 1, '08.
Shepherd Leffler, A. B., Instructor in History; [a b c] Sept. 1, '08.
Kate Coad, B. S., Instructor in Domestic Art, [a b c] Sept. 1, '08.
Rosemund Kedzie, B. S., Instructor in Domestic Art; [a b c] Sept. 1, '08.
Mabel Long, Instructor in Physical Culture; [a b c] Sept. 1, '08.
Mrs. Lillian L. Peppard, Instructor in Domestic Art and Domestic Science; [a b c] Sept. 1, '08.
Ruth Carrel, B. S., Instructor in Bacteriology; [a b c] Sept. 1, '08.
Mary Smith, B. S., Instructor in Bacteriology; [a b c] Sept. 1, '08.
William E. Laycock, Instructor in Physics; [a b c] Sept. 1, '08.
Thomas W. Mason, B. S., Instructor in Chemistry; [a b c] Sept. 1, '08.
Ward H. Parker, B. S., Instructor in Chemistry; [a b c] Sept. 1, '08.
J. Wershow, A. B., Instructor in Chemistry; [a b c] Sept. 1, '08.

Merrill A. Yothers, B. S., Instructor in Entomology; [a,b,c] July 1, '08.

Lee W. Harrington, A. B., Instructor in Zoology; [a,b,c] Sept. 1, '08.

Margaret Dupee, S. B., Instructor in Botany; [a,b,c] Jan. 1, '09.

Laurence B. Brink, A. B., Instructor in English; [a,b,c] Jan. 1, '09.

Antoinette A. Robson, Instructor in German and English; [a,b,c] Jan. 1, '09.

Roscoe Gilmore Stott, A. B., Instructor in English; [a,b,c] April 1, '09.

M. F. Johnson, B. S., Instructor in Mathematics; [a,b,c] April 1, '09.

Norman P. Pope, B. S., Instructor in Drawing; [a,b,c] Jan. 1, '09.

Hector MacPherson, M. S., Instructor in Economics and Sociology; [a,b,c] Jan. 1, '09.

H. E. Marsh, B. S., Instructor in Physics; [a,b,c] Jan. 1, '09.

Benjamin B. Roseboom, Jr., B. S., Instructor in Zoology; [a,b,c] Jan. 15, '09.

E. C. Baker, Foreman of the Foundry; [a,b,c] Nov. 1, '97.

Andrew P. Krentel, Foreman of the Wood Shop; [a,b,c] Sept. '02.

William R. Holmes, Foreman of the Forge Shop; [a,b,c] Sept. 1, '06.

Ralph S. Hudson, B. S., Farm Foreman; [a,b,c] Dec. 1, '07.

Carl C. Wilcox, M. E., E. E., Foreman of the Machine Shop; [a] Oct. 1, '07; [b,c] Sept. 1, '08.

A. H. Davis, Foreman of the Horticultural Department; [a,b,c] Sept. 1, '08.

W. F. Raven, Live Stock Field Agent, [a,b,c] April 1, '09.

A. R. Potts, Field Agent Soils and Crops; [a,b,c] April 9, '09.

O. K. White, B. S., Horticultural Field Agent; [a,b,c] April 1, '09.

Linda E. Landon, Librarian; [a,b,c] Aug. 24, '91.

Agnes Crumb, Assistant Librarian; [a] Aug. 12, '07; [b,c] March 1, '08.

Elida Yakeley, Registrar; [a] July 15, '03; [b,c] June 1, '08.

William J. Wright, B. S., Clerk to the President and Editor M. A. C. Record; [a,b,c] Aug. 1, '07.

Jacob Schepers, Cashier; [a,b] May 1, '07; [c] July 1, '07.

Luther F. Jenison, Bookkeeper; [a,b,c] May 1, '07.

J. H. Rand, Purchasing Agent; [a,b,c] Aug. 1, '08.

Maud A. Meech, Clerk to Secretary; [a,b,c] April 1, '08.

Lillian R. Shafer, Clerk to Secretary; [a,b,c] March 15, '09.

*H. L. Ginter, Bulletin Clerk; [a,b,c] June 15, '07.

*Lee DeHart, Bulletin Clerk; [a,b,c] Aug. 9, '08.

L. F. Newell, Engineer; [a,b,c] Jan. 1, '98.

E. A. Bowd, College Architect; [a,b,c] Jan. 1, '02.

Rowena Ketchum, Nurse in charge of College Hospital; [a,b,c] Sept. '09.

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* Resigned.

** Left for remainder of year.

[a] First appointment.

[b] Present appointment.

[c] Present title.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

Jonathan L. Snyder, A. M., Ph. D., L.L. D.	President, *Ex-officio*.
Robert S. Shaw, B. S. A.	Director.
Charles E. Marshall, Ph. D.	Scientific and Vice-Director and Bacteriologist.
H. J. Eustace, B. S.	Horticulturist.
L. R. Taft, M. S.	Consulting Horticulturist.
R. H. Pettit, B. S. A.	Entomologist.
A. J. Patten, B. S.	Chemist.
J. A. Jeffery, B. S. A.	Soil Physicist.
Addison M. Brown, A. B.	Secretary and Treasurer.

ADVISORY AND ASSISTANT STAFF.

L. M. Hurt, D. V. M.	Consulting Veterinarian.
C. P. Halligan, B. S.	Asst. Horticulturist.
O. Rahn, Ph. D.	Asst. Bacteriologist.
A. C. Anderson, B. S.	Asst. Dairy Husbandman.
H. W. Norton, B. S.	Asst. Animal Husbandman.
W. S. Sayer, B. S.	Research Asst. in Bacteriology.
S. L. Jodidi, Ph. D.	Research Asst. in Chemistry.
G. D. Shafer, Ph. D.	Research Asst. in Entomology.
W. Giltner, D. V. M. M. S.	Research Asst. in Bacteriology.
C. W. Brown, B. S.	Asst in Bacteriology.
F. A. Spragg, M. S.	Asst. in Crops (Plant Breeding).
Miss Z. Northrup, B. S.	Asst. in Bacteriology.
Miss L. M. Smith, B. S.	Asst. in Bacteriology.
M. A. Yothers, B. S.	Asst. in Entomology.
C. B. Collingwood, M. S.	Asst. in Chemistry.
Mrs. L. E. Landon	Librarian.

Chatham, Alger County, 160 acres deeded—Leo Geismar in charge.
Grayling, Crawford County, 160 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded—Frank A. Wilken in charge.

STANDING COMMITTEE IN CHARGE.

Hon. William J. Oberdorffer	Stephenson.
Hon. A. P. Bliss	Saginaw.

STATE WEATHER SERVICE

(Under control of the State Board of Agriculture.)

C. F. Schneider, Director United States Weather Bureau..........Grand Rapids.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE

FOR THE YEAR ENDING JUNE 30, 1909.

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1908.	To cash on deposit, college treasurer		$23,832 33	
July 1, 1908.	To cash on hand		2,229 95	
June 30, 1909.	To special appropriation receipts		174,341 22	
	From State Treasurer	$141,000 00		
	From United States Treasurer	26,000 00		
	From institution and other sources	7,341 22		
June 30, 1909.	By special appropriation disbursements			$162,860 42
June 30, 1909.	To current account receipts		300,258 24	
	From State Treasurer, land grant interest	$69,527 13		
	From State Treasurer, one-tenth mill tax	125,000 00		
	From U. S. Treasurer, Morrill fund	35,000 00		
	From institution and other sources	70,072 20		
	From So. Haven Experiment Station	431 42		
	From U. P. Experiment Station	227 49		
	By general account disbursements			301,114 47
	From current account	$283,529 79		
	From supplementary accounts	17,584 68		
June 30, 1909.	By cash on hand			1,398 16
June 30, 1909.	By cash on deposit			35,288 69
			$500,661 74	$500,661 74

TABLE NO. I.—*Tabular exhibit of Secretary's report.*

	Balance sheet July 1, 1908.		Transactions, July 1, 1908, to June 30, 1909.		Balance sheet June 30, 1909.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$2,229 95		$831 79		$1,398 16	
College Treasurer*	23,832 33			$11,456 36	35,288 69	
Special appropriations		$15,408 87	174,341 22	162,860 42		$26,889 67
Current accounts		10,653 41	299,597 45	283,529 79		9,797 18
Supplementary accounts			660 79	17,584 68		
Totals	$26,062 28	$26,062 28	$475,431 25	$475,431 25	$36,686 85	$36,686 85

*Treasurer's statement is greater July 1, 1908, by $3,120.16, and June 30, 1909, by $8,295.33; warrants outstanding.

TREASURER'S ACCOUNT.

	Dr.	Cr.
Balance on hand, July 1, 1908	$26,952 49	
Receipts from State Treasurer and Secretary of College	475,003 55	
Interest on deposits during year	427 70	
Warrants paid July 1, 1908, to June 30, 1909		$458,799 72
Balance on hand, June 30, 1909		43,584 02
Total	$502,383 74	$502,383 74

TABLE NO. 2.—*Statement of special appropriation account for fiscal year ending June 30, 1909.*

Name of appropriation.	Balance of accounts, July 1, 1908.		Receipts during fiscal year.		Total available.	Total expended.	Balance of account, June 30, 1909.	
	Dr.	Cr.	From State treasury.	From institution and other sources.			Dr.	Cr.
Experiment Station		$157 95	*$26,000 00	$5,348 45	$31,506 40	$29,654 86		$1,851 54
Nursery License and Inspection				1,112 45	1,112 45	1,112 45		
Sundry Improvements		2,145 18		865 32	3,010 50	1,133 23		1,877 27
Agricultural Building		4,498 09	140,000 00		144,498 09	121,651 13		22,846 96
Live Stock Special, 1907		5,174 54			5,174 54	5,174 54		
Live Stock, Special Poultry		2,019 65			2,019 65	2,019 65		
Semi-Centennial		1,413 65		15 00	1,428 65	1,165 91		262 74
Weather Bureau	$0 19		1,000 00		999 81	948 65		51 16
Balance	15,408 87						$26,889 67	
Total	$15,409 06	$15,409 06	$167,000 00	$7,341 22	$189,750 09	$162,860 42	$26,889 67	$26,889 67

*United States Treasurer.

TABLE NO. 3.—*Current account, July 1, 1908, to June 30, 1909.*

On account of—	Dr. To disbursements.	Cr. By receipts.
U. S. Treasurer, 19th annual payment under act of congress of August, 1890	....	$35,000 00
State Treasurer, one-tenth mill tax	....	125,000 00
State Treasurer, interest on proceeds of sales of U. S. land grant	....	69,527 13
Advertising	$2,930 15	311 63
Agricultural education	993 94	....
Athletics	1,042 78	1,325 97
Bacteriological	6,556 58	1,631 83
Botanical	1,702 93	13 02
Chemical	4,544 94	3,180 45
Cleaning	2,814 13	351 88
College extension	734 63	....
Contingent building	32,396 48	....
Diploma fees, $530.00; Incidental fees, $7,909.00; Matriculation, $2,512.50; Room rent, $10,382.50; Tuition, $1,165.00; Sundry, $4,389.43	....	26,888 43
Drawing	895 11	38 90
Electric lighting	4,077 02	1,923 03
English	444 23	153 00
Entomology	887 55	68 32
Farm	22,426 68	16,389 70
Forestry	4,361 47	1,052 87
Heating	23,251 58	512 43
History	140 92	38 00
Horticultural	6,717 09	2,676 93
Library	3,917 53	35 86
Mathematical	4,405 43	473 45
Mechanical	12,497 01	1,569 27
M. A. C. Record	1,395 32	555 25
Military	624 45	12 94
Miscellaneous	5,877 22	2,303 95
Office, President's	988 90	....
Office, Secretary's	1,327 59	299 84
Physical	2,556 12	670 50
Registrar	506 81	....
Salaries	120,245 10	1,296 39
Special courses	5,415 88	3,662 54
Telephones	1,453 02	336 03
Veterinary	705 08	68 45
Women's	3,485 55	1,890 86
Zoological	1,210 57	338 60
Total	$283,529 79	$299,597 45
Supplementary accounts:		
Bulletins	$2,807 15	....
Farmers' institutes	8,823 62	$1 88
South Haven experiment station	2,187 65	431 42
Upper Peninsula experiment station	3,766 26	227 49
Balance beginning of period, July 1, 1908	....	10,653 41
Balance at close of period, July 1, 1909	9,797 18	....
Total	$310,911 65	$310,911 65

TABLE NO. 4.—*Experiment Station account for fiscal year ending June 30, 1909.*

On account of—	Disbursements.			Dr. To disbursements.	Cr. By receipts.
	Adams.	Hatch.	State.		
Balance from fiscal year, July 1, 1908					$157 95
Bacteriological department	$2,407 65	$685 34	$32 74	$3,125 73	
Botanical department	313 69	266 52		580 21	
Chemical department	846 81	851 18	1,217 71	2,915 70	249 97
Director's office		591 41	94 43	685 84	
Entomological department	485 15	574 05	14 28	1,073 48	
Farm department	25	2,659 38	95 50	2,755 13	601 78
Horticultural department	50	1,407 80		1,408 30	
Library		311 39	12 24	323 63	
Live Stock		3 70		3 70	
Salaries	6,761 40	7,316 61	1,564 96	15,642 97	610 00
Secretary's office		332 47	543 00	875 47	4 20
Sundry			80 00	80 00	80 00
Soil Physicist	184 55			184 55	
Veterinary		15		15	
U. S. Treasurer for fiscal year					26,000 00
Fertilizer fees					3,802 50
Balance on hand June 30, 1909				1,851 54	
Total	$11,000 00	$15,000 00	$3,654 86	$31,506 40	$31,506 40

TABLE NO. 5.—*Regular employees and salaries.*

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experiment station.		
President's office:					
President	$5,000 00	$5,000 00			House.
Clerk	1,000 00	1,000 00			
Clerk	600 00	600 00			
Agricultural Department:					
Dean	3,000 00	2,000 00	$1,000 00		House.
Professor of Agronomy	2,100 00	2,100 00			
Ass't Prof. Animal Husbandry	1,500 00	1,400 00	100 00		
Ass't Prof. Dairy Husbandry	1,500 00	1,400 00	100 00		
Instructor Dairying	900 00	900 00			
Instructor Agriculture	1,000 00	1,000 00			
Ass't Prof. Poultry Husbandry	1,400 00	1,400 00			
Instructor Farm Mechanics	1,200 00	1,200 00			
Instructor Blacksmithing	700 00	700 00			
Foreman College Farm	660 00	660 00			
Instructor Live Stock	800 00	800 00			
Live Stock Field Agent	1,500 00	1,500 00			
Live Stock Field Agent	780 00	780 00			
Clerk	600 00	600 00			
Bacteriological Department:					
Professor	2,300 00	1,300 00	1,000 00		
Assistant Professor	1,300 00	1,150 00	150 00		
Research Ass't. in Bacteriology	1,200 00		1,200 00		
Research Ass't. in Bacteriology	1,100 00		1,100 00		
Assistant in Bacteriology	750 00		750 00		
Assistant in Bacteriology	500 00	250 00	250 00		
Assistant in Bacteriology	360 00		360 00		
Assistant in Bacteriology	360 00	360 00			
Botanical Department:					
Professor	2,000 00	2,000 00			House.
Assistant Professor	1,300 00	1,300 00			
Instructor Botany	850 00	850 00			
Instructor Botany	800 00	800 00			
Instructor Botany	700 00	700 00			
Chemical Department:					
Professor	2,300 00	2,300 00			
Assistant Professor	1,300 00	1,300 00			
Instructor	1,150 00	1,150 00			
Instructor	765 00	765 00			
Instructor	765 00	765 00			
Instructor	765 00	765 00			
Chemist Experiment Station	2,000 00		2,000 00		
Research Ass't Chemist Exp. Sta.	1,200 00		1,200 00		
Ass't Chemist Exp. Station	900 00		900 00		
Drawing Department:					
Professor	2,300 00	2,300 00			
Assistant Professor	1,200 00	1,200 00			
Instructor Drawing	800 00	800 00			
Instructor Drawing	800 00	800 00			
Instructor Drawing	700 00	700 00			
Instructor Drawing	600 00	600 00			
English Department:					
Professor	2,000 00	2,000 00			House.
Assistant Professor	1,150 00	1,150 00			Rooms.
Instructor	750 00	750 00			
Instructor	750 00	750 00			
Instructor	750 00	750 00			
Instructor	750 00	750 00			
Instructor	750 00	750 00			
Instructor	900 00	900 00			
Instructor	700 00	700 00			
Instructor	700 00	700 00			
Instructor	700 00	700 00			
Instructor	650 00	650 00			
Instructor	750 00	750 00			
Instructor	480 00	480 00			

TABLE NO. 5.—*Continued.*

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experiment station.		
Entomological Department:					
Professor	$1,800 00	$1,100 00	$700 00		House.
Instructor	700 00	350 00	350 00		
Research Ass't. in Entomology	1,200 00		1,200 00		
Forestry Department:					
Professor	2,000 00	2,000 00			
Instructor	1,000 00	1,000 00			
History and Pol. Economy Dept:					
Professor	2,000 00	2,000 00			
Assistant Professor	1,300 00	1,300 00			
Instructor	750 00	750 00			
Instructor	700 00	700 00			
Instructor	700 00	700 00			
Horticultural Department:					
Professor	2,000 00	1,400 00	600 00		House.
Assistant Professor	1,200 00	800 00	400 00		
Instructor	1,200 00	1,200 00			House.
Instructor	800 00	800 00			
Foreman of Grounds	600 00	600 00			House.
Field Agent	1,200 00	1,200 00			
Institutes and Nursery Inspector:					
Superintendent	2,000 00	2,000 00			House.
Library Department:					
Librarian	1,000 00	880 00	120 00		Rooms.
Assistant Librarian	500 00	500 00			
Mathematics Department:					
Professor	2,000 00	2,000 00			House.
Associate Professor	2,050 00	2,050 00			
Ass't. Professor Civil Eng.	1,400 00	1,400 00			
Ass't. Professor Mathematics	1,100 00	1,100 00			
Instructor Civil Engineering	900 00	900 00			
Instructor Civil Engineering	850 00	850 00			
Instructor Mathematics	850 00	850 00			
Instructor Mathematics	800 00	800 00			
Instructor Mathematics	800 00	800 00			
Instructor Mathematics	700 00	700 00			
Instructor Mathematics	700 00	700 00			
Instructor Mathematics	700 00	700 00			
Instructor Mathematics	900 00	900 00			
Mechanical Department:					
Dean	3,000 00	3,000 00			House.
Assistant Professor	1,400 00	1,400 00			
Assistant Professor	1,400 00	1,400 00			
Instructor	1,200 00	1,200 00			
Instructor	850 00	850 00			
Foreman Woodshop	800 00	800 00			
Foreman Foundry	800 00	800 00			
Foreman Forge Shop	800 00	800 00			
Clerk	540 00	540 00			
Miscellaneous:					
Architect	1,500 00	1,500 00			
Engineer	1,200 00	1,200 00			
Plumber	900 00	900 00			
Night Watchman	480 00	480 00			
Nurse	450 00	450 00			
Physics Department:					
Professor	2,300 00	2,300 00			
Instructor	1,200 00	1,200 00			
Instructor	1,000 00	1,000 00			
Instructor	900 00	900 00			
Instructor	800 00	800 00			
Instructor	700 00	700 00			

TABLE NO. 5.—*Concluded.*

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experiment station.		
Department of Physical Culture:					
Director	$2,000 00	$2,000 00	....	....	....
Secretary's Office:					
Secretary	2,000 00	300 00	$700 00	$1,000 00	House.
Cashier	1,200 00	1,000 00	200 00	....	....
Bookkeeper	700 00	500 00	200 00	....	....
Clerk	700 00	575 00	125 00	....	....
Clerk	550 00	550 00	....	....	....
Purchasing Agent	1,000 00	1,000 00	....	....	....
Clerk, bulletins	550 00	....	550 00	....	....
Veterinary Department:					
Professor	2,000 00	2,000 00	....	....	....
Women's Department:					
Dean	1,600 00	1,600 00	....	....	Rooms.
Instructor Sewing	800 00	800 00	....	....	Rooms.
Instructor Domestic Science	900 00	900 00	....	....	Rooms.
Instructor Physical Culture	600 00	600 00	....	....	Rooms.
Instructor Music	1,000 00	1,000 00	....	....	....
Instructor Cooking	700 00	700 00	....	....	Rooms.
Instructor Domestic Art	350 00	350 00	....	....	....
Zoological Department:					
Professor	2,000 00	2,000 00	....	....	House.
Assistant Professor	1,200 00	1,200 00	....	....	....
Instructor	700 00	700 00	....	....	....
Instructor	700 00	700 00	....	....	....
Agricultural Education:					
Professor	2,200 00	2,200 00	....	....	....
Total pay roll	$149,155 00	$132,900 00	$15,255 00	$1,000 00	....

TABLE NO. 6.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature.			From U. S. Congress.			Total.
	For current expenses.	For special purposes.	Land sales, salt spring and swamp land grants.	Morrill act of 1862, interest from land grant and trespass.	Hatch act of 1887, and Adams act of 1906, experiment station.	Morrill act of 1890, supplementary endowment.	
1855..	....	....	$56,320 00	....	....	....	$56,320 00
1856..	....	....	....	....	....	....	....
1857..	$40,000 00	....	....	....	....	....	40,000 00
1858..	....	....	....	....	....	....	....
1859..	37,500 00	....	....	....	....	....	37,500 00
1860..	....	....	....	....	....	....	....
1861..	6,500 00	....	152 25	....	....	....	6,652 25
1862..	10,000 00	....	218 97	....	....	....	10,218 97
1863..	9,000 00	....	407 80	....	....	....	9,407 80
1864..	9,000 00	....	726 09	....	....	....	9,726 09
1865..	15,000 00	....	1,156 61	....	....	....	16,156 61
1866..	15,000 00	....	1,094 27	....	....	....	16,094 27
1867..	20,000 00	....	7,608 38	....	....	....	27,608 38
1868..	20,000 00	....	592 49	....	....	....	20,592 49
1869..	20,000 00	$30,000 00	17,559 00	$58 96	....	....	67,617 96
1870..	20,000 00	....	1,320 02	2,720 93	....	....	24,040 95
1871..	18,250 00	10,500 00	4,135 72	3,785 54	....	....	36,671 26
1872..	18,250 00	3,000 00	217 05	7,175 65	....	....	28,642 70
1873..	21,796 00	15,602 00	10 13	11,059 06	....	....	48,467 19
1874..	13,000 00	15,602 00	150 13	14,061 98	....	....	42,814 11
1875..	7,638 00	7,755 50	144 53	14,446 14	....	....	29,984 17
1876..	7,638 00	6,755 50	1,773 09	16,830 17	....	....	32,996 76
1877..	6,150 00	30,686 80	979 06	15,172 86	....	....	52,988 72
1878..	6,150 00	5,686 80	826 60	15,807 09	....	....	28,470 49
1879..	4,971 80	16,068 32	712 22	16,978 22	....	....	38,730 56
1880..	4,971 80	7,068 32	797 55	17,837 24	....	....	30,674 91
1881..	7,249 00	43,720 50	461 95	20,935 25	....	....	72,366 70
1882..	7,249 00	8,945 50	358 46	22,507 45	....	....	39,060 41
1883..	8,385 00	23,793 00	391 95	30,749 60	....	....	63,319 55
1884..	8,385 00	10,526 00	1,259 90	27,909 72	....	....	48,080 62
1885..	....	35,103 00	187 50	29,770 40	....	....	65,060 90
1886..	....	22,617 00	....	30,461 04	....	....	53,078 04
1887..	....	*44,040 00	198 20	†24,611 37	....	....	68,849 57
1888..	....	30,752 50	144 20	32,406 60	$15,000 00	....	78,303 30
1889..	....	*20,973 00	10 50	31,322 69	15,000 00	....	67,306 19
1890..	....	*27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891..	....	22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892..	....	22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893..	....	18,862 50	10 50	37,927 04	15,000 00	18,000 00	89,800 04
1894..	....	18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895..	....	‡19,000 00	10 50	45,301 85	15,000 00	20,000 00	99,312 35
1896..	....	‡16,000 00	....	43,886 40	15,000 00	21,000 00	95,886 40
1897..	....	§17,700 00	....	43,779 54	15,000 00	22,000 00	98,479 54
1898..	....	‖17,500 00	....	47,508 28	15,000 00	23,000 00	103,008 28
1899..	....	¶8,750 00	705 00	52,526 11	15,000 00	24,000 00	100,981 11
1900..	....	¶72,500 00	175 00	72,298 38	15,000 00	25,000 00	184,973 38
1901††	....	¶72,500 00	....	63,976 79	15,000 00	25,000 00	176,476 79
1902..	100,000 00	**1,000 00	....	64,081 81	15,000 00	25,000 00	205,081 81
1903..	100,000 00	**1,000 00	....	65,573 90	15,000 00	25,000 00	206,573 90
1904..	100,000 00	**1,000 00	61 19	67,312 37	15,000 00	25,000 00	208,373 50
1905..	100,000 00	*81,000 00	....	72,035 32	15,000 00	25,000 00	293,035 32
1906..	157,810 00	*15,000 00	....	70,286 56	15,000 00	25,000 00	284,096 56
1907..	173,410 00	**1,000 00	....	70,155 22	23,691 60	25,000 00	293,256 82
1908..	173,410 00	**1,000 00	....	70,385 79	23,326 10	30,000 00	298,121 89
1909..	173,410 00	**1,000 00	....	69,527 13	26,000 00	35,000 00	304,937 13
Totals.	$1,440,123 60	$825,937 74	$101,723 66	$1,489,757 01	$358,017 70	$460,000 00	$4,675,559 71

*Including appropriation for weather service.
†October 1, 1886, to June 30, 1887, nine months.
‡Including $5,000 for institutes and $1,000 for weather service.
¶Including $5,500 for institutes and $1,000 for weather service.
‖Including $5,500 for institutes and $1,000 for weather service.
§Including $2,750 for institutes and $500 for weather service.
††To June 30. **Weather service.

SUMMARY OF INVENTORY, JUNE 30, 1908.

College farm and park, 671 acres		$46,970 00
Athletic field and drive, 13 acres		1,137 50
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Wells Hall, rebuilt 1905-06	55,000 00	
Williams Hall, built in 1869	30,000 00	
Abbot Hall, built 1888, addition in 1896	15,000 00	
Chemical laboratory, built 1871, south end addition 1881	18,000 00	
Machine shops and foundry, 1885, south end addition 1887	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	7,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouse and stable, built 1873, 1879, rebuilt 1892 and 1902	6,000 00	
Boiler house and chimney, built 1893-4	3,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Six brick dwellings, built 1857, 1879 and 1884	18,000 00	
One frame house, built 1885	3,500 00	
Howard Terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Six barns at professors' houses	1,050 00	
Horticultural barn and shed, built 1868, 1875 and 1877	1,200 00	
Bull barn, rebuilt 1905	1,500 00	
Sheep barn, rebuilt 1906	2,500 00	
Horse barn, built 1906	5,000 00	
Grade herd barn, rebuilt 1905	4,000 00	
Piggery, rebuilt 1907	1,500 00	
Dairy barn, rebuilt 1900	4,000 00	
Farm mechanics building, built 1881	1,500 00	
Poultry house, built 1906	1,000 00	
Incubator house, built 1906	500 00	
Poultry house, built 1907	1,500 00	
Three poultry houses, built 1907	300 00	
Ten brooder houses, built 1908	250 00	
Corn barn, built 1878	400 00	
Stock judging barn, built 1894	200 00	
Brick work shop, built 1857	500 00	
Observatory, built 1880	100 00	
Bath house and fittings, built 1902-3	17,000 00	
Paint shop, rebuilt 1903	150 00	
Hospital, built 1894	3,000 00	
Postoffice and waiting room, built 1902	1,700 00	
Lumber shed, mechanical department	250 00	
Three silos	600 00	
Coal shed, built 1899	700 00	
Women's building, built 1900	91,000 00	
Dairy building, built 1900	15,000 00	
Bacteriological building, built 1902	27,000 00	
Power house, built 1904	25,000 00	
Amount carried forward	$473,800 00	$48,107 50

Amount brought forward	$473,800 00	$48,107 50
Coal shed, built 1905	6,500 00	
Tunnel system, built 1904	45,000 00	
Cold storage, rebuilt 1905	2,000 00	
Engineering building, built 1906-07, including heating	110,000 00	
Iron bridge over Cedar river, built 1888	1,500 00	
Bridge to athletic field	500 00	
Manure shed	600 00	
		639,900 00
Heat, Light and Water Department—		
Steam heating plant	$17,577 00	
Bath house plant	698 00	
Water works plant	12,760 00	
Telephones	2,000 00	
Electric light department	8,658 10	
Tools and fixtures, steam and water	1,536 54	
Stock	93 71	
Electric light stock	1,269 44	
Plumbing stock	549 77	
		45,142 56
Bacteriological Department—		
Literature	$75 38	
College chemicals	848 65	
College apparatus	7,127 53	
College fixtures	1,210 45	
		9,262 01
Botanical Department—		
Herbarium	$1,871 42	
Museum	845 60	
Books	806 92	
Negatives	239 58	
Photos and engravings	943 05	
Lantern slides	263 24	
Microscopes and accessories	1,847 67	
Glassware, etc.	565 23	
Chemicals	71 82	
Office and classroom equipment	799 42	
General equipment	194 97	
Garden tools	55 06	
		8,503 98
Chemical Department—		
Cases and fixtures	$3,310 60	
Electric	1,267 70	
Platinum	2,367 57	
Graduated glassware	1,162 36	
Ungraduated glassware	3,863 49	
Organic chemicals	319 47	
Inorganic chemicals	705 76	
Balances	1,743 00	
Weights	668 95	
Mercury	28 33	
Special apparatus	1,886 95	
Rubber	72 50	
Specimens	497 85	
Metals	48 65	
Hardware	977 37	
Tools	57 15	
Assay room supplies	187 42	
Porcelain	813 80	
Amount carried forward	$19,978 92	$750,916 05

Amount brought forward	$19,978 92	$750,916 05
Wooden	112 23	
Miscellaneous	272 80	
		20,363 95
Farm Department—		
Agronomy division	$2,384 33	
Farm mechanics	3,644 22	
Live stock, swine	1,327 50	
Live stock, horses	5,750 00	
Live stock, cattle	12,286 00	
Live stock, sheep	3,718 00	
Grade herd barn	34 85	
Dairy barn	66 25	
Bull barn	12 35	
Sheep barn	61 60	
Tool barn	1,542 99	
Horse barn	302 35	
Poultry	918 20	
Dairy	1,294 11	
Meat house	126 85	
Office library	1,705 41	
Office	568 26	
		35,743 27
Horticultural Department—		
Heavy tools	$546 00	
Teams and harnesses	676 50	
Miscellaneous	560 45	
Greenhouse tools	286 94	
Zoo	112 00	
Greenhouse plants	1,581 15	
Office	2,004 79	
Classroom	522 36	
Laboratory equipment	440 25	
Tools	283 50	
		7,013 94
Mathematical Department—		
Transits	$2,659 30	
Levels	1,504 35	
Sextants	245 25	
Miscellaneous surveying instruments	476 73	
Plumb bobs	19 56	
Apparatus	1,090 53	
Tools	34 65	
Drawing instruments and materials	204 65	
Books and pamphlets	275 03	
Photographic material	58 25	
Astronomical laboratory	838 50	
Abbot Hall classrooms	54 00	
Room 8 College Hall	36 50	
Compasses	469 80	
Room 2 College Hall	372 15	
Offices 104 and 105 Engineering Hall	720 93	
Office 110 Engineering Hall	211 00	
Office Room 202 Engineering Hall	417 70	
Office Room 108 Engineering Hall	94 70	
Room 106 Engineering Hall	605 32	
Room 107 Engineering Hall	273 80	
Hydraulic laboratory	325 83	
Room 404 Engineering Hall	205 00	
Room 401 Engineering Hall	18 70	
Amount carried forward	$11,212 23	$814,037 21

Amount brought forward	$11,212 23	$814,037 21
Classroom 304 Engineering Hall	491 58	
Classroom 306 Engineering Hall	506 98	
Classroom 302 Engineering Hall	30 80	
Classroom 203 Engineering Hall	30 80	
Office 305 Engineering Hall	199 82	
Rods and poles	412 22	
Tapes and chains	355 64	
		13,247 07
Mechanical Department—		
Office supplies and equipment	$5,213 34	
Experimental laboratory	9,614 35	
Machine shop	8,733 39	
Foundry	1,329 45	
Forge shop	1,964 33	
Wood working machinery and tools	3,292 52	
Front office, Mechanical Building	156 00	
Miscellaneous	373 20	
		30,676 58
Department of Physics—		
Furniture and fixtures	$2,792 77	
Mechanics	599 05	
Sound	170 70	
Galvanometers	597 80	
Resistance boxes	1,696 20	
Balances	292 00	
Static electricity	996 00	
Magnetism	46 50	
Electrical engineering	9,180 48	
Heat	406 15	
Light	1,439 20	
		18,216 85
Women's Department—		
Reception room and hall	$652 75	
Dean's office	189 10	
Day students' room	255 00	
Parlor	639 50	
Guest room	62 75	
Dormitory furniture	1,689 35	
Miscellaneous	152 19	
Recitation room	6 85	
Store room	29 95	
Dark closet	60 28	
Music rooms	2,217 38	
House library	100 30	
Gymnasium	614 92	
Shower bath rooms	66 55	
Domestic art department	974 11	
Library	80 86	
Office	107 65	
Kitchen utensils	234 69	
Laundry	70 00	
Glassware	18 28	
China	55 14	
Crockery	17 24	
Miscellaneous	35 71	
Linen	41 26	
Dining room furniture	97 40	
		8,469 21
Amount carried forward		$884,646 92

Amount brought forward		$884,646 92
Department of Zoology and Geology—		
General museum	$17,993 00	
Furniture and apparatus	1,526 38	
Tools	28 63	
Dissecting instruments	65 97	
Drawing instruments and material	12 00	
Photographic supplies	327 60	
Microscopic	1,103 27	
Miscellaneous	823 50	
		22,180 35
Carpenter shop		719 48
Cleaning supplies		180 35
Drawing Department, furniture and equipment		4,505 70
English Department, furniture and equipment		646 14
Entomological Department, furniture, supplies, etc		3,747 14
Farmers' Institutes, furniture, etc		584 44
Fire Department, equipment		724 83
Forestry Department, furniture, tools, etc		11,160 58
Furniture in Board Rooms		151 90
Furniture in Wells Hall		1,560 00
Furniture in Chapel		576 80
Furniture in Postoffice		269 50
Department of History and Economics		434 60
Hospital		228 90
Library		53,863 11
Military		1,231 30
Nursery and Orchard Inspection Department		87 46
Paint Shop		371 60
Physical Culture and Athletics		723 62
President's office		628 57
Secretary's office		1,354 89
Veterinary Department, apparatus and equipment		2,274 11
Weather Service		1,500 12
Miscellaneous		751 00
Total		$995,103 41

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved	1,000 00	
160 acres at Chatham, including buildings	4,000 00	
		$6,000 00
Buildings—		
Bacteriological stable	$3,700 00	
Experiment station feed barn	800 00	
Veterinary laboratory, experimental rooms	250 00	
House	1,000 00	
Station Terrace building	3,000 00	
Seed room	500 00	
Slaughter house	625 00	
Storage barn	600 00	
Insectry	1,000 00	
		11,475 00
Bacteriological Department—		
Literature	$2,151 48	
Chemicals	274 24	
Apparatus	2,805 93	
		5,231 65
Chemical Department—		
Apparatus	$1,773 87	
Chemicals	245 88	
Porcelain ware	45 10	
Office furnishings	81 80	
Tools	4 95	
Platinum	686 30	
Filter paper	25 54	
Glassware	368 30	
		3,231 74
Entomological Department—		
Office	$1.807 80	
Books	530 20	
Apparatus	1,070 70	
Supplies	88 04	
Glassware	223 78	
Chemicals	104 70	
Spraying machinery	54 35	
Sundry	65 40	
		3.944 97
Farm Department—		
Farm tools and equipment	$909 98	
Apparatus—soil department	476 22	
Office	341 01	
Books	13 90	
Apparatus	326 10	
Glassware	22 23	
Sundry	5 48	
Dairy	1.323 55	
Dairy office	2 40	
		3,420 87
Horticultural Department		88 54
Library		4,415 50
Secretary's office		253 93
South Haven Station, equipment		337 80
Upper Peninsula Station, equipment		1,224 16
Total		$39,624 16

REPORT OF THE PRESIDENT.

To the Honorable State Board of Agriculture:

Gentlemen—I take pleasure in submitting herewith my report, as President of the college under your control, for the year ending June 30th, 1909.

The year was one of marked progress. The increase in attendance over the previous year was about 16 per cent. The total number of students who received instruction last year was 1,370. Of those entering regular courses, a larger percentage than heretofore were able to qualify for the four year courses, and those entering five year courses were of higher grade than of previous years. There is a gradual improvement in the preparation of students entering our freshman and sub-freshman classes. The graduating class this year numbered ninety-eight. Fifty graduated from the engineering course, fourteen from the home economics course, twenty-eight from the agricultural course and six from the forestry course. Advanced degrees were conferred in accordance with the regulations laid down by the Board as follows:

Edmund Roswell Bennett, M. Hort. William Rutherford Brown, C. E. Albert George Craig, M. Hort. Frank William Howe, M. S. James Garfield Moore, M. Hort. Ernest Alfred Richmond, M. E. George Whitney Williams, M. E.

Dr. Isaac C. Ketler, D. D., LL. D., President of Grove City College, Pennsylvania, delivered the baccalaureate sermon, on the afternoon of June 20th, in the armory. The commencement exercises were held at the same place on June 22nd. The address on this occasion was given by Dr. Charles S. Howe, Ph. D., D. Sc., President of the Case School of Applied Science, Cleveland, Ohio. Commencement functions had a good local attendance but as there was nothing of importance to induce alumni to return this year a comparatively small number of them were present. As the regular triennial reunion will occur next year it was thought wise to defer the dedication of the new agricultural building until that time.

CHANGES IN FACULTY.

It is a pleasure to record that no important changes will take place in the faculty at the close of this year. A number of instructors and several assistant professors, whose services have been valuable to the college, have for various reasons tendered their resignations. It is to be regretted that so many young men of promise as teachers, feel called upon to resign in order to take up practical work.

CHANGES IN BOARD.

This institution when organized in 1855, was placed under the control of the State Board of Education. In 1861, the State Board of

Agriculture was created by the Legislature and given charge of the college. This Board at that time consisted of six members appointed by the Governor and confirmed by the Senate. The appointments were so arranged that two members retired each two years. In 1905 the Legislature added another member to the Board. This member was appointed in the same way, and for the same length of term as the other members, but it was stipulated that he should be a resident of the Northern Peninsula of the state. The Governor of the state and the President of the college were ex-officio members of the Board. The new constitution of the state, which was adopted by the vote of the people in November last year, changed the organization of the Board and the method of the selection of its members. It provides that, "There shall be elected on the first Monday in April, nineteen hundred nine, a state board of agriculture to consist of six members, two of whom shall hold office for two years, two for four years and two for six years. At every regular biennial spring election thereafter, there shall be elected two members whose term of office shall be six years. The members thus elected and their successors in office shall be a body corporate to be known as 'The State Board of Agriculture.'" Under this act the following persons were elected as members of the new Board:

Wm. H. Wallace, Bay Port, term of six years.
I. Roy Waterbury, Highland, term of six years.
Robert D. Graham, Grand Rapids, term of four years.
A. J. Doherty, Clare, term of four years.
W. L. Carpenter, Detroit, term of two years.
W. J. Oberdorffer, Stephenson, term of two years.

The Legislature passed an act fixing the time at which the new Board should take charge as January 1st, 1910. This act also repeals several former acts relating to the college and makes other changes rendered necessary by the new constitution.

On account of the shortage of funds in our State Treasury, it was deemed advisable not to ask the last Legislature for additional appropriations. Our sources of income at present are as follows: Interest from the fund accruing from the sale of land appropriated by Congress under the Morrill act of 1862, $69,527.13; from the second Morrill act of 1890, $25,000.00; from the act of 1907, know as the Nelson Amendment, $10,000.00; from the Hatch act of 1887, $15,000.00 and from the Adams act of 1906, $11,000.00. It will be observed that these funds come to us from the Federal Government. We received from the state last year $173,410.00, income from our one-tenth mill tax. In addition to these funds, we have the receipts from the various departments, fees, room rent, etc.

BUILDINGS.

The Board has decided to erect an addition to the botanical building in the near future. This will add practically six recitation rooms and will afford accommodations which have been very much in demand for several years. The Federal Government has already let the contract for the erection of a building for the weather bureau service. The Legislature authorized the Board to sell to the Federal Government a suitable piece of ground as a site for this building. The location decided upon is directly west of the college hospital. The building will cost from $12,000.00 to $15,000.00, and will no doubt be an ornament to our campus.

The college is very much in need of additional buildings. A million dollars could be very appropriately expended within the next five years. Such an outlay would not be extravagance, but would simply meet the demands which are pressed upon us by the rapid increase of students.

It has been the policy of the college first of all to provide such room as is necessary, in order that the students may receive high grade instruction. This required additional laboratories and recitation rooms. It was felt that these should be provided first—hence, to meet these demands, the engineering building and the agricultural building have been erected at a cost of something like $300,000.00. Other needs, however, are very pressing. Our library which is of exceptional merit, is housed in very cramped quarters, and in a building which is liable to burn at any time. On account of lack of room, we are compelled to store a large number of books in other buildings. Our students can not secure anything like the full benefit of our library and reading room as long as it remains in its present quarters. The danger from fire is a constant source of anxiety to all concerned. We are also greatly in need of an auditorium. Our chapel will accommodate less than 25 per cent of our students. The armory, which serves for drill purposes, as well as for social functions, can be used as an auditorium only at great inconvenience, and at best is very unsatisfactory. The college should also have a gymnasium. It is doubtful whether there is another college in the country of the same size and importance, which is not provided with a building for this purpose. A gymnasium building would provide a place for holding social functions, particularly society parties. It is the desire of the faculty to center the social life of the institution on the campus. A gymnasium with parlors, would to a large degree provide satisfactory quarters for the holding of social functions. At present the armory is entirely inadequate to meet all the demands made upon it, and other quarters should be provided at the earliest possible date. The social life of the student body is very important, and should be provided for with almost as great care as the instructional side of their work. The action of the Board prohibiting the erection of society houses makes it very desirable that additional dormitory accommodations be provided for young men in the near future. Such a building will pay fair interest on the investment, and at the same time provide very comfortable quarters for the students at a small cost. The increase in the attendance of young women will make it very desirable to build the additional wing to the women's building as soon as possible.

During the past year, special efforts have been put forth by the college to render assistance to the farmers of the state. The Department of Agricultural Education has organized a Farm Home Reading Circle, which bids fair to interest a large number of people. During the past year 193 persons have taken the reading prescribed by this course. This department has always put forth a vigorous effort to introduce the teaching of agriculture into high schools. One high school has had a department of agriculture in operation during the past year. It was in charge of one of our graduates and has been eminently successful. Next year five other high schools will introduce the teaching of agriculture and have employed graduates of the college to carry on this work. After a careful investigation, we are firmly of the opinion that the teaching of agriculture can be brought to a larger number of young people and in equally as satisfactory manner through our high schools as could be accomplished by the organization of separate agricultural schools. If instruction in elementary agriculture is ever to become anything like universal throughout the state, it must be made a part of our public school education. The introduction of agriculture in our high schools is very promising, and we believe that this action on the part of the college will result in great good to the agricultural interests of the state. The college has also made an effort to assist the farmers during the past year by placing in the field three men who give their entire time to the interests of the farmer. Mr. W. F. Raven has under the direction of the Dean of our Agricultural Department during the past year organized about twenty Breeder's Associations. These associations are incorporated for a term of thirty years. The object is to induce farmers and especially dairymen to use pure bred sires. Each association is required to purchase not less than three registered sires. These are shifted every two years, which makes it necessary to purchase new sires once in six years. The members of each association must own forty females for each sire, or one hundred and twenty in all. Some of the associations are much larger. One having purchased eighteen sires; another nine, etc. It is safe to say that these twenty associations have purchased at least one hundred registered sires during the past year. These associations have led to the purchase of registered sires by many individuals. It is claimed that as a result of this movement fully as many sires have been purchased by individuals as by the associations. It is probable that not less than two hundred registered sires have been purchased this year as the result of Mr. Raven's work. The greatest good that will come from these organizations will be the result of continuous breeding by dairymen along one line. It is predicted that in a few years this movement will lead to the development of high grade herds throughout the state. It is also destined to produce other favorable results. Many members of these associations are purchasing one or more registered females, and are starting in to develop thoroughbred herds. It will also result in developing certain breeds in certain localities. One section will breed Jerseys, another Holsteins, another Guernseys, etc. This will center the interest of a community on one breed, which is found to be a great advantage in the way of marketing surplus stock.

Our field men in horticulture and soils while at work only during the last few months of the year have created considerable interest, and the outlook for their work in the future is very promising. The college in carrying this work to the farmers is properly fulfilling one of its important functions, and will we believe by so doing, receive the hearty approval of its constituency.

NAMES OF GRADUATING CLASS.

Agricultural graduates are designated by *a*, Engineering by *e*, Home economics by *h* and Forestry by *f*.

Name.	Postoffice.	County.
Allen, Mary Geraldine, *h*	Detroit	Wayne.
Allen, Gerald Henry, *e*	Detroit	Wayne.
Anibal, Ben Henry, *e*	Linden	Genesee.
Ashley, Myron Billings, *a*	Davison	Genesee.
Baumgrass, William Jacob, *e*	Lansing	Ingham.
Belknap, Leon Van Rens, *e*	Whittemore	Iosco.
Belknap, Leslie Howard, *e*	Whittemore	Iosco.
Bignell, George Andrew, *e*	Smyrna	Ionia.
Bowerman, Myron Ralph, *e*	Hillsdale	Hillsdale.
Boyd, David Leonidas, *e*	Albion	Calhoun.
Brodie, Robert Chester, *a*	Portland	OREGON.
Burroughs, Fay Farnham, *e*	Galesburg	Kalamazoo.
Cameron, Bertha Clifford, *h*	Wacousta	Clinton.
Clark, Briggs Lyman, *e*	Howell	Livingston.
Cavanagh, Joseph A., *a*	Mt. Pleasant	Isabella.
Cobb, Charles Cary, *e*	Lansing	Ingham.
Colby, Zenas Eugene, *e*	East Lansing	Ingham.
Crosby, Amos Hale, *a*	Three Oaks	Berrien.
Dains, Frank H., *e*	Lansing	Ingham.
Dunlap, Charles, *e*	Mt. Pleasant	Isabella.
Dickson, Robert Emmett, *f*	East Lansing	Ingham.
Edwards, Charles H., *f*	Houghton	Houghton.
Edwards, Charles Wm., *a*	Hastings	Barry.
Emery, Clyde Lamont, *e*	Marshall	Calhoun.
Esselstyn, Helen Martha, *h*	Lansing	Ingham.
Fairbanks, Oscar William, *e*	Holland	Ottawa.
Fisher, Stacey Stephen, *e*	Redford	Wayne.
Frazer, William David, *e*	Buffalo	New York.
Garcinava, Alfonso, *a*	Durango	MEXICO.
Gardner, Shirley May, *h*	Lansing	Ingham.
Gilbert, Glenn Arthur, *a*	Moline	Allegan.
Gorton, Clyde, *e*	Hopkins	Allegan.
Graham, Olive Estelle, *h*	Lansing	Ingham.
Greenhoe, Claude, *e*	Sheridan	Montcalm.
Graybill, Jacob Light, *a*	Palmyra	PENNSYLVANIA.
Hall, Florence Louise, *h*	Port Austin	Huron.
Harrison, Howard Histand, *e*	Athens	Calhoun.
Hartman, William Henry, *e*	St. Joseph	Berrien.
Hoopingarner, Roy Gabriel, *a*	Bronson	Branch.
Hopphan, Karl Earnest, *e*	Lansing	Ingham.
Hubbard, George F., *a*	Clarkston	Oakland.
Hubbard, Nelson Blood, *e*	Marine City	St. Clair.
Hudson, Edith F., *h*	Okemos	Ingham.
Hudson, M. Ethlyn, *h*	Okemos	Ingham.
Hulett, Edwin B., *a*	Okemos	Ingham.
Hutchins, Alem J., *a*	Hanover	Jackson.
Hyde, Leta Hannah, *h*	Prairieville	Barry.
Ingall, Harlow Dewey, *a*	Morenci	Lenawee.
Jerome, Ben, *e*	Grayling	Crawford.
Kamps, George Bernard, *e*	Zeeland	Ottawa.
Kempster, Harry Laverne, *a*	Coldwater	Branch.
Kierstead, Friend Hans, *e*	East Lansing	Ingham.
Kline, Justin Harold, *e*	Hillsdale	Hillsdale.
Knight, Seth Fred, *e*	Buchanan	Berrien.
Koch, Catherine Elizabeth, *h*	Buffalo	NEW YORK.
Kurtz, Raymond Lapp, *e*	Flint	Genesee.
Lapworth, Charles Wm., *e*	Detroit	Wayne.
Latson, Alice Leoni, *h*	Howell	Livingston.
Lyon, Roy Robert, *e*	Mayville	Tuscola.
Lindsley, Geo. W., *a*	Harbor Springs	Emmet.
McCadie, James Henry, *e*	Standish	Arenac.
McCullough, Nelson, *e*	Milford	Oakland.
McDevitt, Justin John, *e*	Detroit	Wayne.
Martin, Grace I., *h*	Lansing	Ingham.
Mason, Charles Wilkins, *a*	Pittsburg	PENNSYLVANIA.
Mitchell, John Alfred, *f*	Detroit	Wayne.
Moss, Walter Neil, *e*	Lakeview	Montcalm.
Murdock, Russell Alger, *e*	Bay Port	Huron.
Nash, Claude Lawrence, *a*	Belding	Ionia.
Oviatt, Charles J., *a*	Bay City	Bay.
Parker, Frank, *e*	Sherman	Wexford.
Perkins, Lawrence Lewis, *e*	Flushing	Genesee.
Pokorny, Otto Arthur, *e*	Detroit	Wayne.
Postiff, Walter, *a*	Greenfield	Wayne.
Pratt, Burr Bartram, *a*	Benton Harbor	Berrien.

Names of graduating class.—Concluded.

Agricultural graduates are designated by *a*, Engineering by *e*, Home economics by *h* and Forestry by *f*.

Name.	Postoffice.	County.
Pratt, Judson E., *a*	Lansing	Ingham.
Pratt, Hubert Cushman, *e*	Lansing	Ingham.
Raynor, Alleen, *h*	Grand Rapids	Kent.
Reynolds, Robert Morley, *a*	Rapid City	Kalkaska.
Roberts, Benjamin H., *a*	Grand Rapids	Kent.
Robertson, James Earl, *e*	Fremont	Newaygo.
Severance, Myrta H., *h*	East Jordan	Charlevoix.
Smith, Leroy Clark, *e*	Lansing	Ingham.
Sobey, Albert, *e*	Hancock	Houghton.
Sprague, Milton W., *a*	Vermontville	Eaton.
Spurway, Charles H., *a*	Clio	Genesee.
Stafford, William Rogers, *e*	Port Hope	Huron.
Stephen, Glenn Hough, *e*	Vassar	Tuscola.
Tanner, Russell Vaughn, *f*	Munith	Jackson.
Taylor, Chandler C., *a*	Shelby	Oceana.
Taylor, Floyd Clyde, *e*	Charlotte	Eaton.
Taylor, Reese Warner, *f*	Ilion	NEW YORK.
Tower, Max L., *a*	Charlotte	Eaton.
Trout, Winford C., *a*	Grand Rapids	Kent.
Valentine, Floyd Herbert, *e*	Lansing	Ingham.
Webb, Frank Kline, *e*	Benton Harbor	Berrien.
Welles, Jacob Sloat, *a*	Elmira	NEW YORK.
Wood, Frank Esler, *e*	East Lansing	Ingham.

STATISTICS OF ENTERING CLASS.

Items.	Men.	Women.	Totals.
Number entering	400	122	522
Average age	19.7	18.9	19.3
Schools:			
High	294	100	394
District school	34	7	41
College	14	5	19
State Normal	5	2	7
Private school	44	7	51
State University	9	1	10
Support while here:			
Parents	202	94	296
Self	126	18	144
Parents and self	57	1	58
Other sources	15	9	24
Proposed occupation:			
Chemist	3		3
Engineer (agricultural)	1		1
Engineer (civil)	33		33
Engineer (electrical)	22		22
Engineer (mechanical)	90		90
Engineer (mining)	6		6
Engineer (marine)	1		1
Farmer	48		48
Forester	70		70
Horticulturist	5		5
Mechanic	1		1
Miscellaneous	23	4	27
Teacher	1	73	74
Uncertain	96	45	141

Church membership.

Denominations.	Members.	Preference.	Total.
Baptist	26	39	65
Church of Christ	3	3	6
Church of Christ (Scientist)	....	3	3
Congregational	38	62	99
Episcopal	9	16	25
Evangelical	2	5	7
Hebrew	3	2	5
Lutheran	10	3	13
Methodist Episcopal	49	77	125
Methodist Protestant	1	....	1
No preference	....	....	70
Presbyterian	45	28	73
Presbyterian (United)	1	....	1
Roman Catholic	18	1	19
Temple Bethel	1	....	1
United Brethren	2	1	3
Unitarian	1	3	4
Universalist	2	5	7

Counties represented in entering class.

Alpena	4	Kent	39
Allegan	6	Lapeer	5
Antrim	7	Lenawee	17
Barry	7	Livingston	5
Bay	7	Mackinac	1
Benzie	2	Macomb	7
Berrien	9	Manistee	8
Branch	5	Mason	2
Calhoun	5	Mecosta	3
Cass	3	Midland	1
Charlevoix	8	Missaukee	1
Cheboygan	4	Monroe	5
Chippewa	1	Montcalm	5
Clare	4	Muskegon	4
Clinton	4	Newaygo	2
Delta	1	Oakland	1
Dickinson	6	Oceana	9
Eaton	5	Osceola	5
Emmet	4	Otsego	3
Genesee	10	Ottawa	10
Gladwin	1	Roscommon	2
Grand Traverse	6	Saginaw	7
Gratiot	10	Sanilac	6
Hillsdale	3	Schoolcraft	1
Houghton	1	Shiawassee	9
Huron	2	St. Joseph	9
Ingham	90	Tuscola	11
Ionia	31	Van Buren	3
Iosco	1	Washtenaw	10
Jackson	15	Wayne	38
Kalamazoo	3	Wexford	5

Other states represented.

California	1	Minnesota	1
Canada	1	New Jersey	1
Georgia	1	New York	14
Connecticut	1	Ohio	5
Illinois	1	Washington, D. C	1
Indiana	4	Wisconsin	2
Iowa	1	Wyoming	1
Massachusetts	1		

In my report of last year, I called the attention of the Board to the conditions of social life at the institution, and the desirability of maintaining the democratic spirit. The Board was led later by certain requests from societies to make a thorough investigation with reference to the question of society buildings. The report of the Board which was issued as College Bulletin Volume III, Number 11, is printed herewith.

AGRICULTURAL COLLEGE BULLETIN, VOL. III, NO. 11.

REPORT OF THE PRESIDENT OF THE BOARD.

To the Honorable State Board of Agriculture:

Gentlemen—At a meeting of our Board held at Mt. Pleasant on Feb. 24th, there was a communication received from the Hesperian Literary Society, requesting the Board to state upon what conditions it might be accorded the privilege of erecting a society building on the campus. A request similar to this was received from another society a year or more ago. Many questions have arisen recently with reference to the policy of the Board concerning the erection of society buildings as living homes for students. The Board desiring to reach an intelligent and safe conclusion, directed its president to make a full investigation of the whole matter and to report to the Board at a later meeting. This report I now have the honor of presenting.

The policy to be pursued by the Board concerning the erection of society houses seemed to be a question in which the alumni would feel a special interest, and whose advice might indicate a wise solution of the problem. Hence, the following letter of inquiry was mailed to all the living alumni whose addresses are known except the five last classes. Recent graduates change their addresses so frequently that it was felt inadvisable to try to reach them at this time. There were about seven hundred inquiries sent out, to which two hundred and seventy-eight replies were received. The letter mailed out was as follows:

"Grand Rapids, Mich., March 8, 1909.

"My Dear Sir—You are no doubt acquainted with the rapid development in recent years of your Alma Mater, the Michigan Agricultural College. This rapid growth has brought many perplexing problems to the Board of Control. We have endeavored to provide physical equipment and competent teachers commensurate with its needs, but just now we are called upon to settle another problem, in the settlement of which we are anxious to secure the assistance and advice of a few of our able alumni. We feel that their judgment should have much influence in determining our course of action; therefore, I am directed by the Board to request your opinion as to the proper course to pursue with reference to the following:

"We have, as you perhaps know, some ten literary societies for young men. They might very properly be called local fraternities. The college has nine suites of rooms in Williams and Wells Halls which are available for the use of these societies without charge. Two societies have built houses—one on the campus, which is used for social and literary purposes only—the other off the campus which is used as a home for its members, providing living rooms and boarding facilities. It is in all respects a modern fraternity house.

"At least three or four other societies are anxious to build houses of the latter type, either on or off the campus. In their favor the claim is made that at the majority of our large universities fraternity houses are very common, permitted and sanctioned by the Board of Control of these universities; and that modern student life demands that some students draw away from the student body and form fraternal communities where they may live apart from the masses in perhaps a freer way than the dormitory affords. It is claimed that this fraternal life is more pleasant, forms closer friendships and on the whole is commendable.

"On the other hand it is claimed that these fraternity houses add very much to the cost of living; that only young men of considerable means can afford to live in a fraternity house; that fraternities dictate the social life of a university or college and naturally set a pace which the farmer boy or ordinary young man cannot follow; that they tend to seclusion and aristocracy rather than to freedom and democracy.

"These are but a few of many arguments put forth on both sides. The problem is no doubt familiar to you.

"The question is, shall the college foster the fraternity idea of housing students and permit the building of fraternity houses with rooming and boarding facilities, or shall it follow the traditions of bygone years and erect more dormitories and mess halls and restrict society houses to social and educational purposes, thus fostering the broader and seemingly more democratic idea. If the latter plan is thought advisable, it is not believed that we shall find it difficult to secure appropriations for the erection of dormitories, as they will pay a fair interest on the investment.

"A full explanation of this problem can be found in the last report of President Snyder, a copy of which will be mailed you under another cover.

"Will you not write me fully on this question. I can assure you that we shall appreciate your judgment in the matter. As we hope to make a final decision at our next Board meeting, may I not hear from you within a few days?

"Thanking you on behalf of the Board for the reply which I hope you will kindly grant, I am

Very truly yours,
R. D. Graham."

It has not been an easy matter to tabulate these replies. While all express an intense interest in the question, some have discussed the problem in general terms and have left their decision to be inferred rather than expressing it in exact language. Such letters are not usually neutral in tone, but with an effort to be fair most of them have been placed in a column by themselves as neither fostering nor prohibiting the erection of society houses for living purposes. As fair an interpretation as I have been able to make would indicate the following:

Number of replies received	278
Number favorable to the erection of society houses for living purposes	35
Number opposed to houses of this character	218
Number who under certain conditions or restrictions might be counted on either side	25

Number received from alumni who have experience as teachers in this and other institutions, many of whom are members of fraternities owning their own fraternity houses.

Number favorable as above	4
Number opposed	37
Number who might be either way under certain conditions	8

These letters speak out very plainly on several important matters.

1. They almost unanimously endorse the dormitory idea. Even those who are favorable to the erection of fraternity houses do not criticise the dormitories, on the other hand they nearly all speak favorably of them as a good way to house students. The democracy of the dormitory and of the institution is set forth very strongly and strong protest is made against any change which may alter the present democratic spirit. This sentiment is almost unanimous.

2. The present type of literary society in vogue at this college is strongly endorsed. A large number speak of the great good they received from the literary features of these societies as well as from the wholesome social life. There seems to be little or no desire to change to the Greek letter fraternity, although a small minority would favor the plan of community life fostered by these fraternities.

3. There is a strong feeling on the part of the alumni that this college while increasing rapidly in numbers should not follow the trend of the large universities in social customs and society life, but that it should rather maintain a simple, wholesome social life free to all alike and within the financial means of the average student who wishes to attend this college. Great stress is laid upon the necessity of keeping the expenses for social affairs so moderate that there will not be an effort to segregate on financial lines.

4. From the testimony of the alumni who are teachers in institutions having fraternity houses and many of whom belong to such fraternities, it seems evident that fraternity houses increase greatly the expense of students. A very prominent alumnus states that at the university with which he is connected, he believes that the expenses of students living in fraternity houses is from six to eight hundred dollars more per year than those residing elsewhere.

5. Many testify that the moral life in many fraternity houses is not free from censure. That unless under very close surveillance the tendency in morals is downward; that this sort of life interferes with scholarship and sets up social standards which are not based on merit.

I herewith submit a few letters which set forth clearly the position of each side and in about the same proportion to the number received. As I did not ask permission to use the names in print I do not feel at liberty to do so.

No. 1. In Favor.

"My Dear Sir:—During the twenty-five years since entering 'M. A. C.,' I have given the social side of student life much careful study. While in college, I lived successively in the democratic atmosphere of Williams Hall, and the more conservative atmosphere of Middle Ward, Wells Hall; was a member both of a secret fraternity and of an open literary society; and served for a time as steward of Club B. Since graduation, I have observed the fraternity house system of Cornell; the dormitory system of Harvard; the combined dormitory and fraternity house system at the University of Maine; and the fraternity house and miscellaneous rooming-about-town system at the University of West Virginia. Personal experience and general observation of and conversation with students, both in college and after leaving college, lead me to favor the fraternity house system, or a combination of that system with the dormitory system, such as is possible at M. A. C. under existing conditions.

"With a suitable matron, the fraternity house affords the best possible substitute for home surroundings while the student is in college; and, if properly conducted, the cost of living need be little if any higher than would be the case in the usual method of boarding.

"The cost would doubtless be somewhat higher than that entailed by the dormitory system; but, with present dormitory accommodations at the college, no student would be forced to enter a fraternity or society; while the advantages of fraternal ties and social training to many young men who come from the farms are beyond computation. The graduate of M. A. C. should be not only a good student, but he should be a well trained man among men. The dormitory may have its influence in this training, so also may the football field, but neither of these factors of college life can fill the place of the college home.

"If practicable, I believe that the fraternity houses should be located upon the campus, thus keeping the students and faculty in close touch, and fostering that 'college spirit' which is essential to the best development and broadest influence of any institution."

No. 2. In Favor.

"My Dear Mr. Graham:—Being a member and a stockholder in the Eclectic Society House, I may possibly be somewhat biased in my opinion as to the propriety of this movement.

"The fraternity idea is by no means new, and it is evidently bound to prevail even at an institution as democratic as the Michigan Agricultural College. I can see no reason why the Board of Control should object to the fraternity idea of housing students. I believe emphatically in the idea of encouraging the social and educational purposes of the college societies, and do not see why this feature cannot be carried out and still allow the fraternities or societies to provide living rooms and boarding facilities. It is the spirit of all fraternities to encourage 'mixing,' and I believe you will find that their teachings and their principles generally are far from what you would term seclusion and aristocracy. An institution with a thousand students is too large and unwieldy to expect to develop and carry on all of its social functions in the broad, democratic way as when I was a student there twenty-four years ago.

"I am familiar with the teachings of fraternities in general and feel that in a home like a fraternity house very much good is done to the members through the fraternal life which they lead. I sincerely hope that the Michigan Agricultural College may grow to such an extent as to demand the building of both dormitories and society houses for the housing of the students who may come to the institution."

No. 3. Opposed.

"My Dear Sir:—I am unalterably opposed to any plan, scheme, or practice in any of our educational institutions supported by public funds, from the primary school to the university, which in any way tends to foster anything like the idea that one student, or any set of students is better, can live better, can enjoy better educational or social advantages, or can be in any different or better position than any other student or set of students. Of course distinctions as to wealth as shown by dress, habits and use of money, which cannot be obviated by school or college management, will appear; but the point I have in mind is that the authorities should do all that is reasonably possible to eliminate such distinctions, and should adopt no policy which will, in the least, tend to create or encourage them.

"We pride ourselves on what we assume to be a fact, and which is, at least in a general sense, correct as a theoretical proposition, that in this country the spirit of equality is fostered by our institutions. One of the principal ways in which this is done is by free education; that is, by supporting schools and colleges at public expense, and by inviting all, rich and poor alike, to secure an education. Now if the free school and college, that is, free education, is a basis and principal source of democracy and equality, we should be very careful to see that this source is not contaminated by a spirit of aristocracy and exclusiveness which can in any degree by wise management be prevented. The people endow the schools and colleges, to the end that opportunity may be equal, and those who manage these institutions owe to the public the obligation to see that in these publicly supported institutions, opportunity shall be equal.

"I do not think any one can reasonably claim that in a college in which students are permitted to create distinctions based on the financial ability of their parents to support them in greater luxury than the average student can afford, there is equal opportunity. The poor student, if possessed of any pride, is discouraged and disheartened by the artificial distinctions based on wealth, by which he finds himself surrounded and from which he is excluded. It will not do to say he should not be so discouraged, for even boards of management and college faculties cannot change human nature.

"I love my Alma Mater, the Michigan Agricultural College. I have watched with interest and pleasure the large development and extended usefulness of this splendid institution, but with jealousy and sadness the inclination to the growth of a spirit of exclusiveness and aristocracy which it did not possess in the good old days of the early '80s, and which is, I believe, foreign to its purposes. I know changes are inevitable, but let them cease to be away from the democratic spirit by which such an institution should be dominated.

"I answer your inquiry by saying that in my best judgment the college should not foster the fraternity idea of housing students and permit the building of fraternity houses with rooming and boarding facilities, but instead, increase the state-owned dormitories and boarding halls, to the end that the spirit of equality, and not that of aristocracy and exclusiveness, may prevail."

No. 4. Opposed.

"Dear Sir:—In reply to your communication of March 8th relative to the college 'Frat' question will say that what I have learned of college life in the past two years has decided that question for me against the tendency to build so-called society and 'Frat homes,' either on or off the campus of any college or university. These exclusive sets dominate the college life at Yale very much to her detriment. The case is almost as bad at Princeton, where the president and faculity have attempted to devise some means to get rid of them. President Eliot, of Harvard, and President Wilson, of Princeton, have often publicly condemned the practice of segregation in college life as being un-American and opposed to democracy.

"In criticism of the arguments in favor of these fraternity houses it may be admitted that they are getting to be very common, and permitted by Boards of Control because such Boards know nothing better to do. They are not sanctioned, however, by very many such Boards, and it is wholly untrue that modern student life demands that some students live apart from their fellows unless it can at the same time be shown that modern life demands that some people should live exclusive and apart from the rest of the people. I know of no classes of whom this could be true except the feeble-minded, the insane and the criminal. The dormitory life was quite free when the writer had the good fortune to be a student at M. A. C. If such life is now too much circumscribed, it is easy to remedy. Besides, the student of M. A. C. who thus lives apart from the mass of his fellows (and so above them you may be sure) misses one of the best things the college has to give him, viz., the college spirit.

"At Yale you may hear of the '$3,000 Frat.,' the '$5,000 Frat.' or the '$10,000 Frat.,' in each case meaning a community of fellows who spend these sums or more each college year. A man of your experience and judgment need not be told that the influence is unfortunate.

"The 'Frat' and other social organizations of a college are essential elements of college life, but they should be controlled in the interest of democracy as against aristocracy, and at such colleges as M. A. C. they should be controlled in the interest of the boy of small means who desires a college education.

"Trusting that M. A. C. will continue to be a truly democratic institution and that the Board of Agriculture will find means to control this tendency to exclusiveness. I am very truly yours."

No. 5. Opposed.

"Dear Sir:—Having lived in ——— for 15 years, in intimate association with university life and being a member of the Delta Tau Delta fraternity, I have positive convictions upon the subject of fraternity life in colleges, especially in chapter houses. All the objections urged against them in your communication are valid and vital. In addition to them is the moral element which, to my mind and in my observation outweighs all the others. The debauchery from alocholic drinks and lewd women so commonly practiced in such places certainly is not needed to develop the best type of American citizenship. The kegs and cases of beer and the obscene dances of nude women so often exhibited in the 'Frat' houses are but the inevitable result of the unrestrained tendencies of young men of plenty of money furnished by indulgent parents and used according to the unrestrained, lustful tastes of a company of boys seeking to outdo each other in ways unmentionable in polite society. I would as soon allow my son to be housed in a saloon or brothel as in many of the 'Frat' houses I know. It will be a sorry day for old M. A. C. when the fraternity idea prevails in the form under consideration in your communication.

"If I have spoken strongly it is because I feel strongly from an intimate knowledge, as a physician, of 'Frat' conditions. Words convey but feebly the abhorrence I have of such conditions as prevail in some 'Frat' houses."

No. 6. Opposed.

"Dear Sir:—There is a distinct difference in the fraternity rooms used for social and literary purposes from fraternity houses used for living purposes, and I believe that your analysis of the advantages and disadvantages of fraternity houses for living purposes expresses the salient points for and against.

"I have always felt that the democratic spirit manifested throughout the student body during the years I was a student (1884 to 1887) was a very valuable feature, and I am afraid that the establishment of fraternity houses may have a tendency to curtail that broader fraternal spirit which should prevail among the students. The conditions of student life at the M. A. C. is essentially different from that incident to the colleges of our large cities, and I feel confident that the conditions of life that they obtain there are far better for the student body. As I look back to my student life in college as I found it there, and in numerous other colleges in this country and Europe in which I have worked, I have never found one which I thought exerted so favorable an influence upon the individual and the student body as a whole as did the conditions at the M. A. C. For the students of colleges in large cities there are greater reasons for fraternity houses for living purposes, but I am very doubtful about the wisdom of making this change at the M. A. C.

"Of course, all that I have said applies essentially to the housing of students in fraternity buildings, and I would not wish to restrict in any way the establishment of societies or fraternities for social and literary purposes, as I believe they add materially to the pleasure and profit of student life. While I have not been able to visit the college as often as I would like I have always been in touch with its affairs and have been very much gratified with the progress of the institution."

No. 7. Opposed.

"My Dear Mr. Graham:—Your letter in regard to literary societies and fraternities at M. A. C. is at hand and I hasten to reply. Four years as a student and six years as a teacher in the college have given me unusual opportunities for knowing about the work and the life that students live at M. A. C. From this knowledge, permit me to say that I am heart and soul in favor of more dormitories at the college and the restriction of society houses to social and educational purposes. I do not believe that a fraternity will ever take the place at M. A. C. that some of the literary societies have filled in the past. Neither do I believe that it is desirable for reasons of economy for the students, nor for democracy of student life, that fraternities be fostered in your institution."

No. 8. Opposed.

From one who served on the Board of Control of a large university for many years, and had four children members of these fraternities.

"My Dear Sir:—I should not be in favor of the encouragement or extension of fraternity houses at our Alma Mater. Personally, I believe that they are 'un-American,' as connected with our educational life.

"They encourage loyalty to the fraternity rather than to the college as a whole.

"The fraternity bodies select recruits from young men and women of wealth and social standing, and in that way destroy the democratic spirit that should characterize student life.

"They are expensive. Dues and social expenses are indispensable, so much so that a poor student cannot afford to belong.

"Some of the wealthier class of students have little ambition for study, and are inclined to expensive and dissipated habits. These infect the rest, especially the younger students to whom they are an example.

"There are hundreds of young men working their way through the university. In very few instances can they belong to a fraternity. They are substantially in a class by themselves. They are excluded from the social life of the university in a great measure. I think that fraternities tend to build up this distinction, to divide the student body into 'Frat' and 'Independent,' and instead of a great democratic body, to divide the students into small guilds or cliques, each working for itself and careless of the general good."

No. 9. Opposed.

"My Dear Mr. Graham:—Your request at hand, and will say that I admire the way the Board is going about the matter of determining the future social policy of the college. I believe this question to be of very great importance, as the social atmosphere of an institution stamps itself indelibly upon the individuality of its alumni.

"M. A. C. has in the past been a democratic institution where the mass of the student body came from the farm and the country town. Its young men and women bring with them a profound respect for the moral, the intellectual and the physical, born of the fertile soil from which they spring. They bring with them wholesome material for the making of truly great people. They are of a serious turn of mind and are looking for those who will take them seriously. They know little of the powers of perverted wealth; they know little of the vices and the artificial standards of society. I venture to say that hundreds of them go through M. A. C. without having these facts forced upon their attention. I believe the old college has turned out a larger percentage of self-respecting, virtue loving men and women than any other school in the United States. The dormitory life has brought the students into close touch. They have learned to sympathize with others; they have learned to honor and respect their superiors. The wealthy students have mingled with the poor and both have grown stronger by reason of the competition. They have gone away with broader sociological views and stronger characters and have become better citizens by virtue of their mutual admiration and respect.

"The society life of M. A. C. was of the right sort, what there was of it. There should have been quarters for about twice as many social organizations. What a pity it was that about half the students were unable to avail themselves of this privilege. When you ask the people of Michigan for an appropriation for more dormitories I suggest that you promise them that their young people will be furnished with an abundance of wholesome social opportunities.

"A public institution mothered by a state is no place for a few favored ones to set up a distinct society of their own in order to segregate themselves and to display their powers over others less fortunate. It is no place for class distinctions to take root and grow. Let the farmer boys and girls believe that the world is a paradise wherein virtue is honored more than wealth until they graduate, when their vision, like the Santa Claus fable, gradually dissolving still leaves them enriched with the faith that some day the whole world may become as pure socially and as free from class prejudice as was their Alma Mater."

No. 10. Opposed.

"Dear Sir:—Elbert Hubbard said in a recent number of the Philistine 'That too much Waldorf Astoria caused the downfall of Babylon and Nineveh,' applying that college wise, too much artificial life in our American colleges is developing a class of effete young men and an incompetent alumni. It is said that Harvard has 5,400 students, of which 5,000 are remittance men; the other 400 are self supporting. The 5,000 are the ones that are heard of in noisy boastings and swagger clothes and manners as devotees of fraternity halls during the college course, and the 400 are the fellows who are heard of thereafter. Whenever an agricultural college that is supposed to be devoted largely to the education of farmers' sons and exalting the dignity of honest labor takes on airs of Eastern colleges filled with pampered rich men's sons with full purses and empty heads, it has rung the knell of its declining years. Nobody believes more thoroughly in honest hilarious fun for students than I, or ever had any more of it, but I believe it should all be conducted with an eye single to the simple life and the things that go to make up for Spartan, sturdy, high-minded, self-respecting manhood and those traits do not flourish best on richly upholstered furniture, easy couches, with social pipe or cigarette, surrounded by the air of swagger that fraternity houses tend to foster.

"I don't believe that ever in the history of M. A. C. will a more sturdy alumni be turned out than now stands to her credit, and these have all been gained without the fraternity feature which to me suggests the feasibility of letting well enough alone, especially along that line.

"Your letter has created a good deal of interest among the alumni as I have received several letters from classmates and others, asking my opinion on the matter and incidentally expressing about the same views that I have expressed to you.

"I should hate to see any marked departure from the good old fashioned times that have made so much of the success of M. A. C."

No. 11. Opposed.

"Dear Friend:—My brother-in-law, a prosperous grocer, sent his boy to the U. of M. He joined a leading 'Frat' and spent eleven hundred dollars in his first and only year. He is now at work in the grocery. Too bad. I say 'cut them out,' or better, keep them out."

No. 12. Opposed.

From an alumnus who has been connected with four institutions.

"Dear Sir:—My observations of 'Frat' houses have taught me that

"(1) They add to the cost of living very much.

"(2) They create a social caste which is unquestionably injurious to the college as a whole, (because all cannot be in it, and because sensible ones do not *want* to be.)

"(3) They increase and foster what may be best described as the 'smart-alecky' spirit, and make the members harder to control.

"(4) They frequently (not always) tend to lower the moral standards of student life. Card playing goes on continuously, and gambling and poker playing usually come in sooner or later. (Perhaps I ought not to say, 'usually.' But they do *very often.*)

"They therefore inevitably destroy the democratic spirit of a college community. In Albion College those not in a 'Frat' are called 'Barbs' (i. e., barbarians). There is a distinct social line in Ann Arbor between 'Frat' and non-'Frat' men.

"As I knew them, the societies at M. A. C., were the best thing of the kind I have ever seen. I was a member of the ——, and I owe everything to that society. I have often thought, that, had it not been for them taking me in when they did, I might have left college never to return, for I was completely discouraged at the time. The best thing about the societies there now is, that they *unite work* and *play*, and 'Frats,' as I have known them, do not.

"More dormitories and more literary societies would seem to me the best plan to pursue at this juncture."

No. 13. Opposed.

Dear Sir:—Replying to your circular letter of March 8th, regarding the advisability of adopting the fraternity house policy at the Michigan Agricultural College and abandoning the dormitory system, I beg to state that, in my opinion, such a change would be extremely unwise. The traditions of the college owe not a little of their vigor and their influence to the spirit of democracy that has always pervaded the dormitory life. The societies, in my day at least, were supplementary to the dormitory life of the students. Even in the Greek letter fraternities which existed at that time, and of one of which I was a member, the fraternity interest was entirely subordinate to the general interests of the student body as a whole. From my experience in various other colleges and universities, I am convinced that this relation should be preserved at any cost. The most unfortunate tendency in university life at present seems to me to be the growth of social class distinctions among the students. The fraternity system, unless checked by a general dormitory system, breeds snobbery, conceit, extravagance, egotism, and a host of other evils that are at entire variance with our American ideals of democracy, simplicity, and equality of opportunity.

"I sincerely trust that my Alma Mater will not be led into this fatal policy."

No. 14. OPPOSED.

"Dear Sir:—Your circular letter of 8th inst. has been forwarded to the writer who is away from home.

"Answering your question, I am convinced that fraternity life as exemplified at our great universities would do incalculable harm to the ideals of high thinking and plain living at the Michigan Agricultural College, would foster a ridiculous aristocracy in the student body and develop social ambitions which should have no place in an educational institution which is supported by the tax payers of our state.

"I think I can state without fear of contradiction that fraternity life has had the effect stated in 99 out of every 100 institutions in the country where it is in existence, in fact, I believe in *every* institution. Even the great universities have found this spirit of aristocracy a menace and have tried to overcome it in vain.

"If it has worked havoc in universities which cater to literary culture among the classes, what would be the effect in an institution devoted to the scientific culture and industrial development of the masses? I believe it would be ruinous to the ideals of our college and should not be permitted, and I believe that my views coincide not only with those held by the majority of the people but with the majority of college-bred men."

Respectfully submitted.

R. D. GRAHAM.

RESOLUTIONS.

The report of President Graham was accepted and the following resolutions adopted:

"In accord with the expressed sentiment of between eighty and ninety per cent. of the alumni heard from, *be it resolved,* that it shall be the policy of this institution to foster the dormitory system of housing students, and that efforts will be made to increase as rapidly as possible dormitory accommodations, eating halls, and quarters for social purposes. Resolved, further, that this Board shall not give its consent to the erection of society houses for living purposes, but it shall encourage the erection of houses by our literary societies for literary and social purposes, it being understood that such houses shall contain rooms for alumni and caretakers.

"The building already erected off the grounds with the consent of, and under the conditions laid down by the Board, shall not be disturbed in the enjoyment of the privileges already granted. The other societies living off the grounds in rented quarters shall be expected to occupy again rooms on the campus when such rooms are properly provided.

"We conceive it to be the duty of a Board placed in charge of an institution maintained by taxation to keep such an institution as far as possible within the reach of the average student. Therefore we adopt this policy and trust it may have the approval of the alumni and other friends of the institution to the end that the democratic spirit which has characterized the college in the past may be maintained, and that it may continue to be an institution where the sons and daughters of all citizens, without distinction, may secure an education which will fit them for the practical duties of life."

Full information concerning work of the various departments of the college can be found in the department reports, printed in this volume.

Respectfully submitted,
J. L. SNYDER,
President.

East Lansing, Mich.,
June 30, 1909.

REPORT OF THE DEAN OF AGRICULTURE.

To President J. L. Snyder:

The following is a report of the Agricultural Department for the year ending June 30th, 1909.

During the year there was but one change in the personnel of the department staff. Mr. F. W. Howe, instructor in Farm Crops, resigned in February to take a position in the office of the Experiment Stations at Washington, D. C.

The policy through the year has been to make careful preparation for the establishment of several divisions to replace the Agricultural Department. The work has expanded and developed to such an extent that the welfare of the institution would seem to demand the inauguration of these separate divisions, each placed in charge of men who can be retained by the institution. We feel that those now in charge of the various divisions have clearly demonstrated their ability to assume the responsibilities of the several offices.

The extension work in live stock has been continued by Mr. W. F. Raven, whose efforts have met with remarkable success. Twenty-one cooperative live stock breeders' associations have been established in the state up to date. These organizations pledge themselves to use only pedigreed sires and nearly all of them are incorporated under state laws. The plans of organization are fully described in Circular No. 4.

During this year extension work was also established in Horticulture and Soils and Crops, the idea being to extend the benefits of the institution to the farmer by direct contact. Special reports of these lines of work will likely be issued in bulletin or circular form during the coming year.

Short Courses in Agriculture—This year two additional courses were added; viz., an eight week's course in Poultry and four in Forestry, thus making a sum total of six courses. A second term or advanced course was also offered in Creamery Management for those who have already taken the first term and have since had not less than three year's practical experience; this course consists largely of scientific work. The following includes a statement of the enrollment in the special courses: General Agriculture 142, Creamery 40, Poultry 8, Fruit 13, Cheesemaking 9, and Forestry 1, making a total enrollment of 213. The success of these courses was entirely satisfactory on account of the interest taken, and unprecedented in view of the fact that almost every man who registered stayed to complete the course; sickness, accident or other causes of absence did not arise.

In view of the fact that added facilities will become available during the coming year upon the completion of the new agricultural building, it would seem highly desirable to offer a series of farmers' courses of but one week each. For example, devote one week to dairy production exclusively, studying dairy breeds and judging, breeding, feeding, registration, etc. Such a course would be offered to breeders and actual producers engaged in the business. Lectures and demonstrations would be given by breeders of long experience in addition to the regular college teaching staff. Courses similar to the one briefly described may be offered in connection with horses, beef cattle, sheep, swine, corn and other cereals, soils, the farmer's woodlot, etc. Such short courses would meet the needs of the man actually engaged in business, who is unable to leave his work except for a short period at a time. It is not intended to offer all these courses during any one year, and for the first season, probably not more than two or three will be presented.

Experimental Union—During the latter part of this year over sixty bushels of improved grains were sent out in small lots to over two hundred farmers. The grains consisted of three selected varieties of oats and one of barley. These grains are being grown under actual farm conditions in sections representing nearly every portion of the state. Reports are to be returned to this office after harvest. This system is being employed for the distribution of choice varieties selected and developed by the college. The majority of those receiving grains were former short course men. It is intended to extend this cooperative work throughout other branches of agriculture.

Brief reports of the newly established divisions of the Agricultural Department are hereafter given.

Prof. A. C. Anderson reports the following from the Division of Dairy Husbandry.

Instruction—The instruction in dairy live stock was given, as heretofore, in conjunction with the other live stock work during a portion of the fall term, to all sub-freshmen agricultural students, and all freshmen agricultural and forestry men, also to all seniors electing dairying.

Twenty-seven juniors received instruction in animal breeding during the fall term.

The instructional work of the winter term was largely devoted to the special courses. The first year short course men were instructed in the breeds of dairy cattle while the second year general agricultural men and the second year creamery men were given work in dairy cattle judging.

The work for the past year in dairy manufactures has been under the immediate charge of Mr. W. B. Liverance. The subject of creamery butter making was taught to all seniors and special dairy students during the fall term, market milk and inspection being given in the winter term and cheesemaking and ice cream manufacture in the spring term. More cream and milk was purchased than formerly which rendered these courses of more practical value.

During the special creamery courses Mr. Liverance was assisted by Mr. Simon Hagadorn, Mr. F. O. Foster, Mr. Claude A. Grove, and Mr. J. C. Gilbert. Thirty-five men took the elementary course and five men the advanced course in creamery butter making. Ten men reported for the special course in cheesemaking. In this work Mr. Liverance was assisted by Mr. E. A. Haven.

An increasingly large number of samples of milk and cream have been tested for the farmers of the state. Assistance to creamery managers, butter makers, and farm dairies has been given both by correspondence and personal interview. Mr. Liverance prepared and conducted a model dairy exhibit at the state fair. He spent two weeks on the institute train in testing milk and cream, and answering questions pertaining to dairy manufactures. We have filled several institute appointments and spent one week on the same train. We assisted in conducting a stock judging contest for young men at the state fair; and have continued to serve as secretary of the Michigan Improved Live Stock Breeders' and Feeders' Association.

The equipment of this division has been materially increased by the purchase of much needed pieces of machinery and some other appliances for manufacture as well as instruction.

The dairy herd has been increased by the purchase of six Jersey heifers thus placing this breed on par with the other dairy breeds owned by the college. An unusually fine bunch of calves was secured from the dairy herds. The surplus bulls have all been sold, and twenty-six heifer calves are being raised, which will in due time strengthen the dairy herds in numbers, quality, and efficiency.

Prof. H. W. Norton, Jr., reports the following from the Animal Husbandry division.

BEEF CATTLE.

The beef herd consists of 22 Shorthorns, 5 Herefords, 9 Aberdeen Angus and 5 Grades for experimental work. Nineteen head were sold in June, at the completion of the third years' feeding in the baby beef experiment.

In this experiment twenty grade cows and their calves were used. The calves were sired by purebred bulls—the first year a Shorthorn, the second a Hereford, and the last an Aberdeen Angus bull. Ten of the cows were allowed to suckle their calves while the other ten were milked and the calves raised on skim milk. Complete individual records were kept with each of the twenty cows throughout the three years, and with all three lots of calves. The calves were marketed in finished condition at 18 months of age. A bulletin giving complete results of the experiment will soon be published. Complete records on a large number of skim milk fed calves to one year of age have been kept by this division in conjunction with the division of dairy husbandry, and a bulletin reporting 63 such records is now in the press.

An educational live stock exhibit was made at the Michigan State Fair at Detroit, and at the West Michigan State Fair at Grand Rapids. Calves from scrub cows, and sired by purebred bulls, were shown to illustrate the result of one cross of good blood on common stock. Calves from the baby beef experiment were shown giving the cost of raising by the two methods, suckling as compared to skim milk feeding, and the three herd bulls were shown as an illustration of breed types in Shorthorn, Hereford and Aberdeen Angus.

HORSES.

The department has seven purebred Percherons—four mares, 2 fillies and a horse colt—three purebred Clydesdales, 2 mares and a mare colt in addition to four teams of grades.

The second feeding trial in the experiment on Economical Wintering of Farm Horses, was carried through this year, continuing the work outlined in the preliminary report. The teams were divided, one horse being fed a regular ration of oats and timothy hay, and the other a cheaper ration made up of ear corn, bran, oil cake and oats, with oat straw, corn stover and hay for roughage. The results showed a reduction of 10 to 12 cents per head daily in the cost of wintering and at the same time the horses showed as good condition as those fed the more expensive ration.

SHEEP.

There are 328 sheep in the flock, of which there are 32 Rambouillets, 12 Southdowns, 20 Dorsets, 32 Shropshires, 32 Hampshires, 30 Oxfords, 20 Cotswolds, and 150 Grades.

The third year of the experiment in the use of succulence vs. dry feeding for ewes and lambs was completed, and the results will soon be published. In this experiment a flock of 50 western ewes has been fed, 25 on a dry ration and 25 on a ration containing succulence, to determine the effect upon the lambs as to condition at birth, growth and rapidity of gain and cost, and the effect upon the ewes as to condition, prolificacy and fleece. Results so far as worked out indicate that while the lot fed the succulent ration were superior in some ways there was not enough difference to make up for the additional cost.

The work of up-grading from common ewes by using a purebred sire was continued. An imported Hampshire ram was purchased and a Southdown ram was secured from New York State.

SWINE.

There are 176 head in the herd representing several breeds, as follows: Berkshires 25, Yorkshires 53, Doroc Jerseys 44, Poland Chinas 17, Tamworths 16, cross breds 21. During the year a pair of Tamworth pigs and a Yorkshire boar were purchased. The herd has been treated, to prevent hog cholera, with the serum furnished by the Bacteriological Department.

Prof. J. G. Halpin reports as follows for the Poultry Division:

The feed house described in last year's report has been completed and found very satisfactory, so that we are now able to carry on, without friction, both class and investigation work in feeds and feeding. The addition of eleven brooders and two incubators gives us sufficient equipment for the hatching and rearing of 2,000 chicks. The new commercial poultry house has proved itself very satisfactory during the past winter and is considered excellent for experimental feeding for the production of eggs.

Our rapidly increasing stock has made it necessary to secure larger summer ranges. To meet this demand, we have been granted permission to use a part of the college orchard and one of the meadows. These ranges are ideal, providing the chicks an opportunity to hunt a large part of their living and unlimited range for exercise over fresh, clean ground.

Our present stock consists of Barred Plymouth Rocks, White Wyandottes, Light Brahmas, Brown and White Leghorns and a few specimens of each of the following breeds for class work: Partridge Wyandotte, Black Langshires, Buff Cochin, Rhode Island Red and White Plymouth Rock, and Cornish Indian Runner ducks.

The instruction work during the year has been as follows:

Fall term: Six men enrolled for Poultry 5b, ten lectures were given the sophomores on breeds and ten lectures to the sub-freshmen on elementary poultry work.

Winter term: Six men enrolled for Poultry 5c and the first winter poultry course was given. Thirteen men took all or a part of this work. Four lectures on feeding were also given the juniors.

Spring term: Four men enrolled for Poultry 5d. We have tried to make the instruction work as practical as possible, and with our increased facilities have been able to give a large amount of practice work.

The experiments with the three colony laying houses have been continued and work begun to test different methods of feeding the laying hens. In addition we are endeavoring to determine the best method for handling breeding stock in the winter.

During the past winter one pen of sixty Barred Plymouth Rock hens was allowed access to the yards at all times, but not forced to go outside for either feed or water; while a similar pen was kept closed during the entire winter, and accurate records kept of the feed consumed and eggs produced.

A study was also made of the fertility of the eggs produced under each of the different conditions. To demonstrate the necessity of feeding the hens early and keeping the windows and other openings as clean and light as possible, electric lights were turned on in a few pens at five o'clock and similar pens left unlighted. Records show production for the hens and growth of the pullets much in favor of the early risers. We do not consider electric light practical but merely wish to emphasize the importance of making the hen's day as long as possible and having her feed ready when she comes off the roost in the morning. We find it well to have some grain left in the litter at night.

In addition to the instruction and experimental work at the college, some judging was done at the fall fairs, a number of farmers' institutes attended and a trip made with the institute train. This year an entire car of the institute train was devoted to poultry, providing plenty of room in which to exhibit specimens of the various breeds kept here, different feeds and feed mixtures and an assortment of poultry machinery such as bone grinders, trap nests, dusting machine, cramming machine, et cetera.

Prof. J. A. Jeffery reports the following from the Soils division:

The average number of students per term to whom instruction has been given by this department is 114, making a total of 342 for the year.

During the fall term there was but one class; during the winter term there were six classes, and during the spring term, four.

College extension work has been done as follows:

We have assisted in the organization of four county boys' corn growing associations, averaging perhaps 350 boys to the association.

We have judged corn at one county boys' association.

We have addressed seven special farmers' meetings, at some of which we also judged corn.

We have taken part in farmers' institute meetings.

There has been no assistant in the department during the year, which fact has interfered with the efficiency of our work.

Instructor L. J. Smith reports the following from the Farm Mechanics division.

The Farm Mechanics Division has had more students this year in the various subjects taught than during any previous year. The freshmen classes in Forge Shop and Wood Shop were so large that some of the students had to be taught during available hours unoccupied by other classes. This difficulty will be overcome next year by arranging the students in smaller classes, and more sections.

The shop equipment was just large enough to handle the Short Course students during the last session. If the number increases next year additional sections will be necessary.

The regular teaching force in this division was ably assisted during the Short Course by Mr. H. H. Musselman, of the class of 1907 of this college. We were very fortunate in securing his services for the Wood Shop work. His experience in carpentry and in the methods of teaching shop work enabled him to handle his classes in a very efficient manner.

We have been able to secure the loan of additional concrete machinery which has strengthened our work along that line. We have also secured a second hand gasoline engine for the use of the junior agricultural students in connection with their practice work in Farm Mechanics 3 and 4.

Mr. A. Anderson of this division resigned, May 31st, 1909, and Mr. Andrew Watt has been secured to fill the vacancy. Mr. Watt has had twenty years experience in blacksmithing and wagon work, and should be capable of filling the position as instructor in Forge Shop in a very acceptable manner.

Respectfully submitted,
ROBERT S. SHAW,
Dean of Agriculture.

East Lansing, Mich.,
June 30, 1909.

REPORT OF THE DEPARTMENT OF HORTICULTURE AND LANDSCAPE GARDENING.

To the President:

I herewith submit my first report of the Horticultural Department:

All classes have been held as scheduled in the catalog, though the subject matter of a few courses has been changed as will be mentioned later.

A careful examination of the subject matter of the courses as pursued during the past two years, convinced me that too much effort was being made to "popularize" the work to the serious detriment of the fundamentals of the science and art of horticulture.

At a college of this kind, it is expected, and justly demanded, that young men be so well trained as to make them valuable as teachers, investigators, and managers, after graduation. It is manifestly impossible to do this by "popularizing" the subject matter of the courses.

With this idea before us, several changes were made, and the aim in the future will be to make the required and preparatory work a means of training in observance and accuracy, and an appreciation of the science of the work. The elective work will be more technical and an effort will be made to train students to do creditable work in horticulture.

The limited amount of money available for campus work makes it impossible to do much more than to keep it looking presentable. Every year sees additions and new buildings that call for grading, planting and more lawns. Nothing has been done to increase the plantings and collection of trees and shrubs. It is hoped that this can be done, and that we can continue to hold the distinction of having "the most beautiful campus in the West."

The gardens and orchards were in need of considerable improvement, and an effort is being made to make them more valuable and to add considerably to the collections of species and varieties.

The extension work that was started by direction of the State Board of Agriculture, promises to become a very important and valuable line of endeavor, not only for the college, but for the horticultural interests of the state. Mr. O. K. White, a graduate of the college, and a successful fruit grower, was secured for the work. Mr. White spends almost his entire time in looking after experiments that have a direct bearing upon local industries, and in demonstrating horticultural practices throughout the state. Demands for his attendance at meetings of farmers interested in better horticulture are great, and will soon be more than he can meet.

The spirit among all connected with the department is of the best; no man incapable of getting along pleasantly with his fellow workers can expect to remain in this department. The duties are exacting and demand longer hours and closer attention than in most other departments, and to be of the most value, it is imperative that all work together.

I take great satisfaction in reporting to you that the work of Assistant Professor Halligan, Instructors Gunson and Gregg, Mr. White, College Field Agent in Horticulture, and Mr. Davis, foreman, has been thoroughly satisfactory.

Respectfully submitted,
H. J. EUSTACE,
Professor of Horticulture.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF BOTANY.

President J. L. Snyder:

With best wishes please accept my report for the year closing June 30, 1909:

A summary of the classes instructed.

Class.	Subject.	Term.	Hours per week.	Students enrolled.
Seniors and Juniors, a, f, h	Plant physiology	Fall	9	5
Seniors and Juniors, a, f, h	Plant physiology	Winter	9	8
Seniors and Juniors, a, f, h	Plant physiology	Spring	9	1
Seniors, f	General morphology	Fall	10	4
Seniors and Juniors, a, f, h	Plant pathology	Fall	7	32
Seniors and Juniors, a, f, h	Weeds	Fall	3	27
Seniors and Juniors, a, f, h	Grasses and forage plants	Spring	6	4
Seniors and Juniors, a, f	Trees and shrubs	Spring	10	10
Sophomores, a, f	Ecology	Spring	4	52
Sophomores, h	Ecology	Spring	1	25
Sophomores, a, f	Histology	Winter	7	60
Sophomores, h	Histology	Winter	4	31
Freshmen, a, f	Systematic	Spring	10	138
Freshmen, h	Systematic	Spring	4	68
Freshmen, a, f	Fruits and seeds	Winter	6	164
Freshmen, h	Fruits and seeds	Winter	6	73
Freshmen, a, f, h	Beginning	Fall	4	251
Summer school	Weeds	Summer	7	20
Short course	Trees	Summer	9	12
Short course	Botany	Winter	7	52
Total				1,037

BOTANIC GARDEN.

Although I had not means to complete the raising of land to high-water mark last year, what had been accomplished made it possible this spring and summer to give the garden a less unfinished appearance than for two or three years past. In moving the plants twice during the period of filling in soil, we lost some plants, while of many others, we had an amount much reduced; for this reason, some of the plats of species are too small, leaving vacant soil between.

As the classes become much larger, and the land of the neighborhood cleared away and "improved," it becomes more and more difficult to secure an ample supply for class use, hence we are giving more attention to growing the plants needed in the garden,—but here comes in an objection to this course; viz., this cutting of flowers for 250-300 or more students detracts much from the beauty of the garden. In this particular we see what this college must come to, by knowing what has happened at Harvard and other old universities. Instead of sending forty to fifty miles for plants needed by students at a cost of $600 to $700 for one semester, the plants at Harvard are now grown in the garden.

THE HERBARIUM.

I name below the few additions made during the current year:

Home collections	100
W. W. Eggleston, Crataegi of the Southern States	44
Emma J. Cole, Crataegi, Grand Rapids, Mich.	16
C. K. Dodge, Crataegi, Port Huron, Mich.	48
S. M. Tracy, Plants of the Gulf States	471
	679

FUNGI.

E. Bartholomew, Fungi Columbiana, Centuries, 27, 28, 29	300

ALGAE.

F. S. Collins, Fascicles XXX, XXI	100
Total additions for the year	1079

GENERAL SUMMARY OF THE PLANTS IN THE HERBARIUM.

Seed Plants, Ferns and their allies	81,906
Mosses and Liverworts	2,010
Lichens	1,186
Fungi	17,653
Algae	2,370
Grand total in herbarium	105,125

THE ARBORETUM.

The report for 1908 contains just what I should say this year.

A BOTANICAL MUSEUM.

In the spasmodic efforts made from time to time for the past ten years to secure a much needed addition to the Botanical Laboratory, I had in mind to use one room for a small museum, but the pressing need of more class room to accomodate a great increase in the number of students, forces me to abandon the museum. From 1880 to 1890, I collected and made a museum housed in the first laboratory, which burned after serving ten years.

The total number of entries of articles was 2,775, though in many instances there were duplicate specimens. Some were purchased, some given us after solicitation, a very few were at the college when I came, but 1,895, over three-fifths of the whole, were collected by my own hands. The cost of the specimens and cases was $5,085, saying nothing about my time, which was no small item. The visitor could have no conception of the labor required to gather, prepare, label, catalog, and arrange such a collection, and it was not yet half completed.

I estimate the value of the specimens saved from the fire at $326. As I have previously shown you, these remnants have occupied rooms in the basement and attic now for seventeen years, besides two years in barns, dwelling houses and elsewhere.

I collected and exhibited timber at the Philadelphia Exposition in 1876, also that held in New Orleans.

As was to be expected, this was largely an economic museum of plant products, and received many complimentary expressions from visitors who not infrequently spoke of it as unique and more interesting than any other museum ever visited.

STATE FAIR.

This is the third year in which I have prepared and kept a plat of economic plants growing on the grounds of the State Fair. This year there are fifty-one kinds of plants.

EXTENSION WORK AND QUESTIONS ANSWERED.

This section of my report is here inserted, as a matter of record, not for the purpose of repeating what you may very likely already know. During the past year, about nine hundred inquiries have come to me for answer, I enumerate some of them. "What weed seeds are contained in enclosed samples of alfalfa, clover, grasses?" Samples of plants infested with fungi, molds, insect galls, bacteria, nematodes; eggs of angleworms had been found in great numbers beneath a pile of tops of sugar beets and it was feared they were some fungous disease; native and cultivated plants were sent for identification; questions concerning meadows and pastures; how to make a lawn, or golf grounds; is it safe to keep clover seed for a few years? "Tell about spraying to kill dandelions and mustard; how to grow ginseng and where get the plants; how to stop drifting sands; mark out a short course for farmers; how to catch moles; can you drain a cat-hole by boring a hole in the bottom? Tell about these marks in boards of white ash; what is this sediment collecting in our fish hatchery?"

Samples of peat from British Columbia to tell what crops will grow on it; asking me to make contributions to an encyclopedia. One unfortunate woman had bought and planted some bulbs which had not grown above ground as soon as she thought they should; she fearing that one kind had been planted wrong end up, wrote to ask what she should do about it.

DONATIONS TO THE DEPARTMENT.

From C. K. Dodge, Port Huron, a gift of 48 species of herbarium specimens of Crataegus.

From E. J. Kraus, living plants of Viola ovata, Trillium undulatum, and purple flowered Trillium.

From the Director of the Kew Gardens, England, packages of seeds.

From Wm. Trelease, Director of the Shaw Botanical Gardens, St. Louis, Mo., packages of seeds.

From Director Ganong, Botanic Garden, Smith College, packages of seeds.

GIFTS TO OTHERS.

From time to time living plants, seeds and other things have been given to worthy people far in excess of those received from others, but I have kept no record of them.

We are to be congratulated on the prospect of retaining our teachers for another year unchanged.

Respectfully submitted,
W. J. BEAL,
Professor of Botany.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

President J. L. Snyder:

Dear Sir:—The teaching during the past year has consisted of classes in:

Personal Hygiene (Sub-freshman only) required of Agricultural students.

Bacteriology (lectures) required of Agricultural and Women students.

Bacteriology (laboratory classes) Elective—open to Agricultural and Women students.

Sanitary Science—Elective—open to Women students only.

Food Hygiene—Elective—open to Women students only.

There is nothing to be added, inasmuch as the work has followed very closely the same lines as during the year previous. Besides the above, class work has been conducted with short course students in creamery management and cheesemaking. This work consisted of lectures and demonstrations, and, in the case of the second year creamery student, laboratory exercises.

In the instruction work of this department for the past year, I have had the most loyal and efficient support and assistance in Dr. Rahn, Dr. Giltner, Mr. Brown, Miss Northrup, and Miss Carrel.

It is very gratifying to acknowledge the value of the "Hospital Cottages" for isolation purposes. In close contact with the fighting of contagious diseases in this institution for thirteen years, I have noted many difficulties in properly isolating patients. We have been obliged to employ scattered and inconveniently arranged and equipped rooms about the campus, making it troublesome in managing the patients, as well as eliminating the disease. By means of the four hospital cottages, each capable of comfortably housing, besides the nurse, six patients, it becomes possible to care for four distinct contagious diseases at once or employ more than one cottage as is usually necessary in measles and similar diseases. I feel that we have probably one of the best systems of isolation hospitals in Michigan, and these at a moderate cost. Last year, when I recommended them in my report, I did not feel at all sanguine that they would be installed before a year had passed. I am certain that the students fully appreciate their value, as well as feel grateful to the Board for granting them. I has made my own duties in this connection much easier.

The first cottage was made available in January for scarlet fever. Since then, we have had the isolation of diphtheria, scarlet fever and measles. Three cottages have been in operation at one time during this year. This situation has occurred twice.

A scheme of these isolation hospitals may be profitably added.

These hospital cottages are provided with two wards, a nurse's room, a bath room, and a kitchen. They are heated by steam, supplied with hot and cold water, gas for cooking, and electricity for lighting.

Another admirable feature consists in turning off the steam for heating, water, light, or gas at will, making it possible to use one or more without incurring unnecessary expense in heating, lighting, et cetera.

In the handling of contagious diseases, I desire to recognize the great vale of the unselfish services of Dr. Oscar Bruegel, the health officer of East Lansing.

The regular hospital has performed the duties devolving upon it in the usual satisfactory manner, owing to the efficient control of Miss Ketchum.

The work in hog cholera serum, and cultures for legume inoculation seemed more fitting to incorporate in my report to the Director of the Experiment Station; accordingly, it will be found there.

Very respectfully submitted,
CHARLES E. MARSHALL,
Professor of Bacteriology.

East Lansing, June 30, 1909.

REPORT OF THE DEPARTMENT OF FORESTRY.

To the President:

COURSE OF STUDY.

The course of study as set forth in my report to you for 1908 was followed throughout the year with the exception of the summer term.

The number of enrollments by terms may be tabulated as follows:

Fall	66
Winter	86
Spring	131
	283

FOREST EXTENSION WORK.

The applications for examination of woodlots during the past 12 months may be tabulated by counties as follows:

Alcona	1	Huron	7	Montmorency	2
Allegan	15	Ingham	10	Muskegon	7
Alpena	2	Ionia	11	Newaygo	3
Antrim	3	Iron	1	Oakland	17
Arenac	2	Isabella	2	Oceana	9
Barry	7	Jackson	7	Ogemaw	1
Benzie	3	Kalamazoo	17	Osceola	1
Berrien	11	Kalkaska	1	Otsego	2
Branch	5	Kent	18	Ottawa	14
Calhoun	12	Lake	2	Presque Isle	2
Cass	4	Lapeer	7	Roscommon	3
Cheboygan	2	Leelanau	2	Saginaw	4
Clare	3	Lenawee	9	Sanilac	4
Clinton	2	Livingston	7	Shiawassee	16
Dickinson	2	Luce	1	St. Clair	1
Eaton	14	Macomb	7	St. Joseph	9
Emmet	2	Manistee	5	Tuscola	3
Genesee	4	Mason	2	Van Buren	11
Gladwin	1	Mecosta	2	Washtenaw	7
Grand Traverse	10	Monroe	4	Wayne	20
Gratiot	6	Marquette	1	Wexford	1
Hillsdale	6	Montcalm	14	Miscellaneous	12
Total	120	Total	137	Total	148

The number of woodlots examined are as follows:

Allegan	12	Jackson	3
Benzie	1	Kalamazoo	10
Berrien	5	Kent	4
Branch	3	Livingston	3
Calhoun	4	Macomb	2
Cass	1	Monroe	1
Clare	1	Montcalm	1
Eaton	3	Oceana	4
Genesee	1	Ottawa	1
Grand Traverse	2	Saginaw	3
Hillsdale	1	Shiawassee	2
Huron	3	Van Buren	6
Ingham	8	Wayne	7
Ionia	1		
			47
	46		
Total			93

Number of trees sold to those interested in forestry 250,730. Number of trees distributed gratis to public institutions 27,174. Number of trees planted in College Woods 8,053. Total number taken from the college nursery 285,957.

There is now on hand in seed beds and nursery rows only the following tree stock:

Coniferous	2,306,929
Broadleaf	149,300

Numerous letters of inquiry show great interest throughout the state along lines of private forest holdings; how best to establish, manage and maintain them. During the past year 5,193 letters have been sent out from the department.

The following donations have been received:

Lufkin Rule Company, Saginaw, Mich.
1 Board rule 12-22.
1 Board rule 12-22.
1 Diam. Hd. Board rule 8-18.
1 Diam. Hd. Board rule 8-18.
1 Board Rule 8-18.
1 Diam. Hd. Board rule 8-18.
1 Diam. Hd. Board rule 8-22.
1 L. H. Board rule 9-16.
1 Board rule 7-16.
1 Board rule Log Rule combined.
1 Steel Board Rule 8-18.
1 Doyle Log Rule 8-20.
1 Scribner Log Rule 8-20.
1 Scribner Log Rule 12-24.
1 Doyle-Scribner Log Rule 12-24.
1 Doyle Log Rule 12-24.

1 Decimal A. Log Rule 12-24.
1 Decimal B. Log Rule 12-24.
1 Decimal C. Log Rule 12-24.
1 Doyle Log Rule 12-24.
1 Doyle-Scribner Log Rule 12-24.
1 Scribner Log Rule 12-24.
1 Doyle Log Rule 12-24.
1 Marking Stick.
1 Dip rod.
1 Lumber Gauge.
100 Assorted Boot Calks.
1 Calk set.
1 Calk set and Punch combined.
1 L. R. Company Sign.

Fall City Lumber Company, Portland, Oregon.
Exhibit of Pacific Coast Woods.

Very respectfully submitted.
J. FRED BAKER,
Professor of Forestry.

East Lansing, Mich.,
June 30, 1909.

REPORT OF THE DEAN OF ENGINEERING.

Dr. J. L. Snyder, President, Michigan Agricultural College:

Dear Sir:—I have the honor to present the report of the Dean of Engineering for the fiscal year ending June 30, 1909.

INSTRUCTION STAFF.

The instruction staff through promotions, resignations, and additions has undergone considerable change since the last report.

Taking effect September 1, 1908, Prof. V. T. Wilson was appointed Professor of Drawing and Design, Messrs. S. C. Hadden, C. Gunderson, and J. A. Polson were promoted from instructors to assistant professors. Messrs. G. James, G. A. Heinrich, C. A. Pierce, W. H. Perkins, W. H. Wadleigh and L. L. Chappelle resigned, and Messrs. P. Rosenberg, W. E. Hawkes, W. E. Laycock, H. L. Slobin, H. P. Case, N. P. Pope, L. S. Fuller, M. F. Johnson, and Miss I. P. Snelgrove were appointed to fill vacancies or additional positions.

In detail, the personnel of the several departments has been as follows:

CIVIL ENGINEERING AND MATHEMATICS.

H. K. Vedder, C. E. Professor.
W. Babcock, B. S. Associate Professor.
S. C. Hadden, B. S. Assistant Professor.
C. Gunderson, A. M., Ph. D. Assistant Professor.

A. E. Jones, A. B. Instructor.
W. B. Wendt, B. C. E. Instructor.
W. R. Cornell, B. Sc. Instructor.
J. T. McVey, C. E. Instructor.
P. Rosenberg, B. S. Instructor.
W. E. Hawks, B. A. Instructor.
L. S. Fuller, B. S. Instructor.
H. L. Slobin, B. A., Ph. D. Instructor.
M. F. Johnson, B. S. Instructor. Teachers 13.

DRAWING AND DESIGN.

V. T. Wilson, M. E. Professor.
C. Newman, Assistant Professor.
Miss C. L. Holt, Instructor.
C. H. Harper, B. S. Instructor.
N. P. Pope, B. S. Instructor.
Miss I. P. Snelgrove, Instructor. Teachers, 6.

ELECTRICAL ENGINEERING AND PHYSICS.

A. R. Sawyer, B. S., E. E. Professor.
W. L. Lodge, B. Sc., M. A. Instructor.
C. W. Chapman, Instructor.
E. N. Bates, B. S. Instructor.
W. E. Laycock, Instructor.
H. E. Marsh, B. S. Instructor. Teachers, 6.

MECHANICAL ENGINEERING.

G. W. Bissell, M. E. Professor.
L. L. Appleyard, B. S. Assistant Professor.
J. A. Polson, B. S. Assistant Professor.
A. C. Mehrtens, M. E. Instructor.
C. C. Wilcox, M. E., E. E. Instructor.
E. C. Baker, Instructor.
A. P. Krentel, Instructor.
W. R. Holmes, Instructor.
A. Smith, Instructor.
H. P. Case, Instructor. Teachers, 10.

Total, 35.

Changes in the personnel for the coming year which are in prospect are the resignation of Messrs. Hadden, Cornell, McVey, Rosenberg, Slobin, Harper, Pope, Chapman and Bates and the promotion of Mr. Lodge to an assistant professorship. Most of the resignations arise from opportunities to do better elsewhere either in the teaching or the practical field.

The amount and distribution of the teaching work among the several departments and through the three terms of the year are shown in Table I and also in the separate reports of the departments which have been filed with the President. Statistical information is not entirely satisfying in this connection but Table I evidences that the instruction staff has been busy.

TABLE I.

Distribution of teaching work in engineering departments, year 1908-9.

Department.	Term of year.	Hours of teaching per week.	No. of classes.	Students enrolled.	Student hours per week.			
					Engineering students.	All others.	Total.	Per teacher.
Civil Engineering and Mathematics.	F......	254	59	1,292	3,631	2,118	5,749	479
	W.....	258	54	954	3,204	1,469	4,873	406
	S......	292	63	1,271	4,625	1,198	5,823	448
	Av'ge..	268	59	1,172	3,820	1,595	5,482	444
Drawing and Design	F......	121	24	666	2,004	1,225	3,229	461
	W.....	99	16	419	1,594	613	2,207	368
	S......	76	14	341	1,130	719	1,849	308
	Av'ge..	99	18	475	1,577	852	2,423	379
Electrical Engineering and Physics.	F......	94	34	580	710	1,019	1,729	346
	W.....	113	36	621	1,438	646	2,084	417
	S......	133	45	716	1,393	1,153	2,546	424
	Av'ge..	113	38	639	1,180	939	2,119	396
Mechanical Engineering.	F......	284	42	777	4,135	....	4,135	413
	W.....	300	39	928	4,846	....	4,846	484
	S......	241	30	547	2,987	....	2,987	298
	Av'ge..	275	37	744	3,989	....	3,989	398
Total or averages for all Departments.	F......	753	159	3,315	10,480	4,362	14,842	425
	W.....	770	145	2,922	11,082	2,728	14,010	419
	S......	742	152	2,875	10,135	3,070	13,205	319
	Av'ge..	755	152	3,034	10,566	3,386	14,019	388

STUDENT ENROLLMENT.

Table II exhibits the enrollment in the engineering course by classes for the college year just closed.

TABLE II.

Seniors	58
Juniors	62
Sophomores	104
Freshmen	178
Sub-freshmen	81
Special students	8
Total	498

This total is but a slight increase over the enrollment for the previous year, due, doubtless in a large measure to the financial depression.

The shrinkage in the enrollment from term to term through the year is notable, particularly in the lower classes, and should receive consideration.

The number of graduates in engineering was 48. In addition professional service degrees were conferred as follows:

Brown, W. E., Civil Engineer, (C. E.)
Richmond, E. A. Mechanical Engineer, (M. E.)
Williams, G. W., Mechanical Engineer, (M. E.)

THE COURSE OF STUDY.

The revision of the course of study, mentioned in the last report, has been completed and is published in the catalog.

I feel that this course, in common with the other four-year courses offered to students of the college, is open to the criticism that if all the work specified is intended to be thoroughly done, the course is too severe for the average student, and I believe it would be better to require less in quantity and more in quality. Twenty credits per term of thorough work is more nearly the proper gauge of attainment for the students than the twenty-five now exacted. I look for a general revision of all courses within two or three years.

I also believe that solid geometry should be an entrance requirement for engineering students and that the preparatory year should be abolished.

SALARIES AND AMOUNT OF WORK OF TEACHING STAFF.

To this subject I devoted considerable space in my last report to which I invite attention at this time. (Pages 55 to 58, Michigan Board of Agriculture, 1908.)

I wish to emphasize here the arguments and facts advanced a year ago and shall take opportunity in and out of season to press the subject of higher salaries and opportunities for study and research for the teachers in engineering until they shall be commensurate with the efficiency desired in our work.

BUILDINGS AND EQUIPMENT.

The Engineering Hall has been very fully utilized during the year. Since the last report, the cement and hydraulic laboratories have been equipped for classes.

Certain requirements of the work are inadequately provided for—notably, the facilities for storing and handling the surveying instruments. At present no solution of this difficulty is in sight. To meet this and other cases of crowded accommodations which will soon arise, the matter of establishing the work in physics in another building should receive early and careful consideration.

The apparatus equipment is growing at a satisfactory rate.

In conclusion I would thank the members of the engineering staff and the President, faculty, and authorities for the help and appreciation extended during the year.

Respectfully submitted,
G. W. BISSELL,
Dean of Engineering.

East Lansing, June 30, 1909.

REPORT OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

Dr. J. L. Snyder, President,
Michigan Agricultural College.

Dear Sir—I present, herewith, my report as professor of mechanical engineering for the fiscal year ending June 30, 1909.

The teaching and administrative staff of the department has been as follows:

G. W. Bissell, Professor.
L. L. Appleyard, Assistant Professor.
J. A. Polson, Assistant Professor.
A. C. Mehrtens, Instructor.
C. C. Wilcox, Instructor.
A. P. Krentel, Instructor.
E. C. Baker, Instructor.
W. R. Holmes, Instructor.
A. Smith, Instructor.
H. P. Case Instructor.
Miss C. B. Purcell, Clerk.

Additional assistance has also been rendered by J. N. Bidwell and J. Campbell to meet crowded conditions in certain classes.

I take pleasure in commending the members of my staff for their cordial and effective cooperation during the year.

Tables I, II, III, subjoined, show the distribution and amount of the instruction given by the several teachers of the department.

In addition to his instructional work, Mr. Mehrtens has written a book of 250 pages, entitled "Gas Engine Theory and Design," published by Wiley & Sons. The work is very creditable to its author and should be in general demand by those who are interested in the subject.

The writer, and W. S. Franklin, Lehigh University, have in preparation a treatise on the steam engine to be published by Macmillan & Co

No notable additions to the material equipment of the department have been installed since my last report. During the coming summer, however, there will be added to the machine shop equipment a 24-inch Cincinnati shaper.

Other improvements to be executed during the summer are a cement floor in the machine shop, the addition of twenty work benches in the wood shop, and the installation of drawing tables in Room 408 of Engineering Hall.

The facilities for instruction in wood work have been severely taxed and the addition to its equipment, above referred to, is in anticipation of the prospective demands of the coming year.

Plans for new shop buildings have been given considerable thought during the year by Professor Appleyard and Mr. Wilcox and during the coming year the plans will be drawn and estimates of cost made.

The department stands in need of considerable additional equipment in the engineering laboratory, partly as duplicate apparatus for the large classes enrolled, and partly as single pieces for advanced work. The latter have been or will be listed in the semi-annual budgets and the expenditure involved should be allowed in order to prevent embarrassment in the conduct of the work.

Respectfully submitted,
G. W. BISSELL,
Professor of Mechanical Engineering.

East Lansing, Mich., June 30, 1909.

TABLE I.

Class work of department of mechanical engineering.—Fall term, 1908.

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours per week.
Sub-freshmen	Wood-shop	2 m	Mr. Krentel Mr. Smith	4	77	308
4-year Freshmen	Wood-shop	2 a	Mr. Krentel Mr. Smith	8	116	928
5-year Freshmen	Wood-shop	2 p	Mr. Krentel Mr. Smith	2	49	98
Sophomores	Forge-shop	2 d	Mr. Holmes	8	46	368
Sophomores	Foundry	2 f	Mr. Baker	8	47	376
Junior and Senior	Machine-shop	1 g, 1 j	Mr. Wilcox Mr. Case	6	79	474
Juniors	Machine-design	6 c	Prof. Appleyard Mr. Mehrtens	6	34	204
Juniors	Metallurgy	11	Prof. Polson	4	69	276
Seniors	Steam engine design	8 b	Prof. Appleyard	6	29	174
Seniors	Kinematics	14 a	Mr. Mehrtens	2	63	126
Seniors	Experimental laboratory	15 a	Prof. Polson	4	51	204
Seniors	Graphics of mechanism	16	Mr. Mehrtens	4	63	252
Seniors	Thermo-dynamics	17	Prof. Bissell	5	54	270
Totals					777	4,078

TABLE II.

Class work of department of mechanical engineering. Winter term, 1909.

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours per week.
Sub-freshmen	Wood-shop	2 n	Mr. Krentel Mr. Smith	4	73	292
4-year Freshmen	Wood-shop	2 b	Mr. Krentel Mr. Smith	8	108	864
5-year Freshmen	Wood-shop	2 q	Mr. Krentel Mr. Smith	6	48	288
4-year and 5-year Freshmen	Elements of engineering	1	Prof. Bissell	4	168	672
Sophomores	Forge-shop	2 e	Mr. Holmes	8	38	304
Sophomores	Foundry	2 f	Mr. Baker	8	42	336
Sophomores	Machine-shop	1 g	Mr. Wilcox Mr. Case	6	43	258
Sophomores	Machine-design	6 a	Mr. Mehrtens Mr. Campbell Mr. Bidwell	6	92	552
Juniors	Machine-shop	1 h	Mr. Wilcox Mr. Case	9	40	360
Juniors	Machine-design	6 d	Mr. Mehrtens Mr. Wilcox	8	47	376
Juniors	Valve gears	9	Prof. Appleyard	2	64	128
Juniors	Boilers	12	Prof. Polson	2	55	110
Seniors	Machine-design	6 e	Prof. Appleyard	8	29	232
Seniors	Power station design	21	Prof. Bissell	2	30	60
Seniors	Eng. Lab	15 b	Prof. Polson	8	27	216
Seniors	Eng. Lab	C. E. 12	Prof. Polson	4	23	92
Totals					927	5,140

TABLE III.

Class work of department of mechanical engineering.—Spring term, 1909.

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours per week.
Sub-freshmen	Wood-shop	2 o	Mr. Krentel Mr. Smith	4	64	256
4-year Freshmen	Wood-shop	2 c	Mr. Krentel Mr. Smith	8	104	832
Sophomores	Forge-shop	2 e	Mr. Holmes	8	24	192
Sophomores	Foundry	2 g	Mr. Baker	8	32	256
Sophomores	Machine-shop	1 g, 1 h	Mr. Wilcox Mr. Case	8	42	336
Sophomores	Machine-design	6 b	Prof. Appleyard Mr. Mehrtens	4	93	372
Juniors	Machine-shop	1 h, 1 i	Mr. Wilcox Mr. Case	8	16	128
Juniors	Theory of design	10	Prof. Bissell	2	23	46
Juniors	Mechanics	7 c	Prof. Polson	5	10	50
Juniors	Materials laboratory	13 a	Prof. Polson	12	43	516
Juniors	Gas engine	22	Mr. Mehrtens	2	33	66
Seniors	Gas engine design	6 f	Mr. Mehrtens	6	13	78
Seniors	Machine-design	6 f	Prof. Appleyard	6	2	12
Seniors	Power station design	18 b	Prof. Bissell	4	5	20
Seniors	Engineering practice	18	Prof. Bissell	2	31	62
Seniors	Thesis	19	Prof. Bissell Prof. Polson	10	14	140
Totals					549	3,362

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

Sir—It would be wasting words to tell you that the year covered by this report has been one of unusual activity. It is due those who have carried through the heavy schedule of classes, to record the large measure of satisfactory results they have produced. With a greater number of classes and in some cases larger sections than ever before, the efficiency of the work has actually increased. All who took part in the work of teaching are entitled to a share of credit for this remarkable showing. With the exception of the writer's name, the following list includes the names and title of those who have formed the departmental staff during the year. There have been no resignations or withdrawals during that time. This list is arranged in order of seniority of appointment.

Warren Babcock, B. S., Associate Professor of Mathematics.
A. E. Jones, B. S., Instructor in Mathematics.
C. Gundersen, A. M., Ph. D., Assistant Professor of Mathematics.
S. C. Hadden, B. S., Assistant Professor of Civil Engineering.
W. B. Wendt, B. C. E., Instructor in Civil Engineering.
W. R. Cornell, B. S., Instructor in Civil Engineering.
J. T. McVey, C. E., Instructor in Civil Engineering.
P. Rosenberg, B. S., Instructor in Mathematics.
W. E. Hawkes, B. A., Instructor in Mathematics.
H. L. Slobin, B. A., Ph. D., Instructor in Mathematics.
L. S. Fuller, B. S., Instructor in Mathematics.

The spring term schedule for this department assumed such proportions that it became necessary to engage an additional instructor. Mr. M. F. Johnson, a graduate of this college, received an appointment as instructor in Mathematics and served very acceptably in that capacity during the term. In both the winter and spring terms the peculiar requirements of our working schedule demanded a few extra hours of assistance in the teaching. Mr. Oscar Fairbanks, a senior in engineering, taught two classes in mathematics through the winter term. Mr. Albert Sobey had charge of one class during the spring term. Mr. Johnson has accepted an engagement to continue as instructor for the next year.

Of the teachers named in the list above seven have announced their intention to resign at the end of the college year. Dr. Carl Gundersen has accepted the chair of mathematics in the University of Oklahoma. Mr. W. R. Cornell has been appointed instructor in Cornell University. Several others have accepted engagements elsewhere.

The present offering of professional studies in the civil engineering department is a result of growth which has been more vigorous than the corresponding growth of facilities both in material equipment and men. More particularly, however, has the college failed to supply teachers in sufficient number for this field and our apportionment of funds has not been adequate to secure instructors of the high grade necessary to teach some of the professional work. With the increasing numbers of students who are electing civil engineering the disparity of skill and knowledge to guide them is becoming noticeable. I feel that in justice to those who seek the kind of training in question, the college should choose one of two alternatives. Either it should provide one more assistant for which salary should be offered large enough to attract a man of considerable experience as well as adequate theoretical training; or it should be made plain to all that we cannot expect to serve as efficiently those who choose civil engineering as we can those who decide upon some other technical line. If funds are lacking to provide more and better teachers it certainly will not be dishonorable or discreditable to make a plain statement of the facts and absolve the college from any charge of deceit or misrepresentation.

The course in civil engineering at this college never has cost in proportion to other lines of work. For two years after the first establishment of a definite course of study in this line no extra expense was incurred on its account; in fact, it is almost certain that the new venture resulted in a saving to the institution because it divided into smaller units some classes which were demanding space in class rooms and laboratories when the quarters provided for these classes were already overcrowded and there was no room for expansion. Since then there is no denying the fact that the element of luck has favored us in providing instruction at all adequate to the growth in demand. Instructors only just out of college with little practical training have developed beyond our expectations and have proven themselves competent to direct the teaching in professional engineering subjects with the results that would ordinarily be expected from men of wide experience only. We cannot always hope for similar good fortune.

The requirements of a crowded schedule have gradually made it necessary to treat our instructors of civil engineering as perfectly interchangeable elements in departmental organization. Again it has been our good fortune that our work has not suffered in consequence. Of course, it would be absurd to believe that an extension of this practice will result in anything but failure. Ultimately our teachers must be specialists and the classes must conform to a schedule whose outline will largely depend upon the specialized capabilities of the teachers and the number of instructors provided.

Another consideration presents itself which has to do with economy of management in the whole department, particularly in the engineering work and to some extent in mathematics. It is not too much to claim that this department applies teaching methods of some individuality which must be maintained in order to carry out the plans of the writer and his advisers. Every withdrawal from the teaching force which has occurred this year will result in a demand for special direction when new teachers are secured. Even if the means of supplying teachers were of the best and no errors of judgment were possible in securing the best talent there would remain the necessity of inducting the new instructors into the methods peculiar to M. A. C. When so many of them need this direction as will be the case the coming year the aggregate demands on the head of the department create a problem in physical endurance.

In view of the many and increasing duties connected with the teach ing side of the department I would again suggest that I be relieved of the responsibilities connected with the teaching of mathematics. The reason for this recommendation is largely a selfish one and is not intended to favor any sharply defined separation of mathematics and engineering at this college. As I have said before, I hope that separation may be accompanied by a fixed policy that shall insist upon the appointment of some teachers of mathematics who shall have had engineering training both in the class room and in practice.

In accordance with our custom, there has been prepared a table showing the work carried by this department during the year. This will answer questions of location, kind of work, and the like, which may be asked concerning the year's activities.

Class work of the department of mathematics and civil engineering for the college year 1907-8.

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting	No. hours per week.	No. of students in class.
Fall term.							
Sub freshmen	M. algebra	Math. 1c	Dr. Gundersen	8 College Hall	3–4	5	22
Sub-freshmen	M. algebra	Math. 1c	Mr. Rosenberg	213 Eng. Bldg	10–11	5	21
Sub-freshmen	M. algebra	Math. 1c	Mr. Rosenberg	213 Eng. Bldg	11–12	5	23
Sub-freshmen	M. algebra	Math. 1c	Dr. Slobin	301 Eng. Bldg	3–4	5	21
Sub freshmen	Ag. & W. algebra	Math. 1	Mr. Fuller	109 Eng. Bldg	1–2	5	18
Sub-freshmen	Ag. & W. algebra	Math. 1	Mr. Hawkes	12 College Hall	1–2	5	21
Sub freshmen	Ag. & W. algebra	Math. 1	Mr. Rosenberg	117 Eng. Bldg	2–3	5	38
Sub-freshmen	Ag. & W. algebra	Math. 1	Dr. Slobin	2 College Hall	10–11	5	29
Sub-freshmen	Ag. & W. algebra	Math. 1	Dr. Slobin	301 Eng. Bldg	2–3	5	13
Freshmen	M. algebra	Math. le	Prof. Babcock	2 College Hall	2–3	5	26
Freshmen	M. algebra	Math. le	Mr. Cornell	302 Eng. Bldg	8–9	5	27
Freshmen	M. algebra	Math. le	Mr. Cornell	302 Eng. Bldg	1–2	5	31
Freshmen	M. algebra	Math. le	Dr. Gundersen	8 College Hall	2–3	5	28
Freshmen	M. algebra	Math. le	Mr. Hawkes	8 College Hall	10–11	5	35
Freshmen	M. algebra	Math. le	Mr. Hawkes	8 College Hall	11–12	5	29
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Fuller	301 Eng. Bldg	10–11	5	25
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Fuller	6 College Hall	9–10	5	20
Freshmen	Ag. & W. algebra	Math. 1b	Dr. Gundersen	203 Eng. Bldg	10–11	5	26
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Hawkes	8 College Hall	8–9	5	22
Freshmen	Ag. & W. algebra	Math. 1b	Prof. Hadden	302 Eng. Bldg	9–10	5	21
Freshmen	Ag. & W. algebra	Math. 1b	Mr. McVey	Abbot Hall	1–2	5	26
Freshmen	M. geom	Math. 2d	Mr Fuller	302 Eng. Bldg	11–12	5	8
Freshmen	M geom	Math. 2d	Prof. Hadden	302 Eng. Bldg	10–11	5	15
Freshmen	M. geom	Math. 2d	Mr. Jones	Abbot Hall	2–3	5	29
Freshmen	M. geom	Math. 2d	Mr. McVey	203 Eng. Bldg	9–10	5	25
Freshmen	M. geom	Math. 2d	Mr. Rosenberg	301 Eng. Bldg	8–9	5	28
Freshmen	M. geom	Math 2d	Dr. Slobin	301 Eng. Bldg	1–2	5	35
Sophomore	Anal. geom	Math. 5	Prof. Babcock	2 College Hall	1–2	5	23
Sophomore	Anal. geom	Math. 5	Dr. Gundersen	8 College Hall	1–2	5	25
Sophomore	Anal. geom	Math. 5	Mr. Jones	Abbot Hall	11–12	5	27
Sophomore	Anal. geom	Math 5	Dr. Slobin	2 College Hall	11–12	5	26
Juniors	Mech. of Eng	Math. 7a	Prof. Babcock	2 College Hall	8–9	5	16
Juniors	Mech. of Eng	Math. 7a	Prof. Babcock	2 College Hall	9–10	5	14
Juniors	Mech. of Eng	Math. 7a	Dr Gundersen	203 Eng. Bldg	11–12	5	13
Juniors	Mech. of Eng	Math. 7a	Mr. Wendt	109 Eng. Bldg	10–11	5	12
Juniors	Surveying	C. E. 1b	Mr. Cornell	118 Eng. Bldg	10–11	2	18
Juniors	Surveying	C. E. 1b	Mr. McVey	109 Eng. Bldg	11–12	2	13
Juniors	Surveying	C. E. 1b	Prof. Vedder	111 Eng. Bldg	10–11	2	18
Juniors	Surveying	C. E. 1b	Prof. Vedder	111 Eng. Bldg	11–12	2	15
Seniors	Ag. C. E.	C. E. 2	Mr. Wendt	109 Eng. Bldg	....	9	22
Seniors	Graphics	C. E. 4	Prof. Vedder	111 Eng Bldg	9–10	3	30
Seniors	Graphics	C. E. 4	Mr. Wendt	111 Eng. Bldg	8–9	3	21
Seniors	Bridge Str	C. E. 8a	Prof. Hadden	111 Eng. Bldg	11–12	3	12
Seniors	Bridge Str	C. E. 8a	Prof. Vedder	111 Eng. Bldg	10–11	3	11
Seniors	R. R. survey	C. E. 7	Prof. Hadden	111 Eng. Bldg	1–4	2	34

Class work of the department of mathematics and civil engineering.—Continued.

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week.	No. of students in class.
Winter term.							
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Cornell	109 Eng. Bldg	1–2	5	14
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Fairbanks	12 College Hall	10–11	5	13
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Fairbanks	12 College Hall	11–12	5	15
Sub-freshmen	Ag & W. algebra	Math. 1a	Mr. Hawkes	217 Eng. Bldg	10–11	5	17
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Hawkes	217 Eng. Bldg	11–12	5	15
Sub-freshmen	Ag. & W. algebra	Math. 1a	Dr. Slobin	301 Eng. Bldg	8–9	5	21
Sub freshmen	M. algebra	Math. 1d	Mr. Fuller	301 Eng. Bldg	11–12	5	24
Sub-freshmen	M. algebra	Math. 1d	Mr. Hawkes	302 Eng. Bldg	8–9	5	21
Sub-freshmen	M. algebra	Math. 1d	Mr. Rosenberg	8 College Hall	8–9	5	14
Sub-freshmen	M. algebra	Math. 1d	Dr. Slobin	8 College Hall	10–11	5	21
Sub-freshmen	Plane geom	Math. 2	Mr. Hawkes	302 Eng. Bldg	3–4	3	19
Sub-freshmen	Plane geom	Math. 2	Mr. McVey	203 Eng. Bldg	9–10	3	17
Sub-freshmen	Plane geom	Math. 2	Mr. Rosenberg	8 College Hall	2–3	3	17
Sub-freshmen	Plane geom	Math. 2	Dr. Slobin	203 Eng. Bldg	1–2	3	23
Freshmen	Ag. geom	Math. 2b	Mr. Cornell	302 Eng. Bldg	10–11	5	21
Freshmen	Ag. geom	Math. 2b	Mr. Cornell	203 Eng. Bldg	3–4	5	15
Freshmen	Ag. geom	Math. 2b	Mr. Fuller	301 Eng. Bldg	3–4	5	14
Freshmen	Ag. geom	Math. 2b	Mr. Fuller	301 Eng. Bldg	9–10	5	23
Freshmen	Ag. geom	Math. 2b	Dr. Gundersen	2 College Hall	3–4	5	18
Freshmen	Ag. geom	Math. 2b	Mr. Hawkes	302 Eng. Bldg	1–2	5	16
Freshmen	Ag. geom	Math. 2b	Mr. Jones	Abbot Hall	10–11	5	20
Freshmen	Ag. geom	Math. 2b	Mr. Jones	Abbot Hall	11–12	5	19
Freshmen	Ag. geom	Math. 2b	Mr. Jones	Abbot Hall	2–3	5	26
Freshmen	Ag. geom	Math. 2b	Mr. Rosenberg	8 College Hall	3–4	5	21
Freshmen	M. algebra	Math. 1f	Prof. Babcock	2 College Hall	8–9	5	18
Freshmen	M. algebra	Math. 1f	Prof Babcock	2 College Hall	2–3	5	15
Freshmen	M. algebra	Math. 1f	Mr. Fuller	301 Eng. Bldg	2–3	5	21
Freshmen	M. algebra	Math. 1f	Dr. Gundersen	111 Eng. Bldg	10–11	5	25
Freshmen	M. algebra	Math. 1f	Mr. McVey	203 Eng. Bldg	11–12	5	17
Freshmen	M. algebra	Math. 1f	Mr. Rosenberg	302 Eng. Bldg	11–12	5	18
Freshmen	M. algebra	Math. 1f	Mr. Rosenberg	8 College Hall	1–2	5	27
Freshmen	M. algebra	Math. 1f	Dr. Slobin	203 Eng. Bldg	2–3	5	17
Sophomores	M. & W. Dif. Cal	Math. 6a	Prof. Babcock	2 College Hall	9–10	5	6
Sophomores	M. & W. Dif. Cal	Math. 6a	Mr. Jones	Abbot Hall	1–2	5	23
Sophomores	M. & W. Dif. Cal	Math. 6a	Dr. Gundersen	111 Eng. Bldg	11–12	5	23
Sophomores	M. & W. Dif. Cal	Math. 6a	Dr. Gundersen	2 College Hall	1–2	5	20
Sophomores	M. & W. Dif. Cal	Math. 6a	Dr. Slobin	8 College Hall	11–12	5	24
Juniors	Mechanics	Math. 7b	Prof. Babcock	2 College Hall	11–12	5	9
Juniors	Mechanics	Math. 7b	Mr. Cornell	302 Eng. Bldg	9–10	5	17
Juniors	Mechanics	Math. 7b	Mr. McVey	203 Eng. Bldg	8–9	5	12
Juniors	Mechanics	Math. 7b	Mr. Wendt	2 College Hall	10–11	5	14
Seniors	Ag. Eng	C. E. 3	Prof. Vedder	111 Eng. Bldg	9–10	5	23
Seniors	Bridge design	C. E. 8b	Prof. Vedder Prof. Hadden	304&306 Eng.Bl.	10–12	8	23
Seniors	Hydraulics (class)	C. E. 5	Mr. Wendt	111 Eng. Bldg	8–9	5	26
Seniors	Exp. Lab	C. E. 12	Mr. McVey Prof. Hadden Mr. Wendt	106-4 Eng. Bdg.	1–5	8	23
Seniors	Hydraulics (lab)	C. E. 5a	Prof. Hadden	3 Eng. Bldg.	1–5	4	26
Seniors	Water supply	C. E. 15	Prof. Hadden	301 Eng. Bldg	9–10	5	22

Class work of the department of mathematics and civil engineering.—Continued.

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week	No. of students in class.
Spring term.							
Sub-freshmen......	Ag. & W. geom......	Math. 2a......	Mr. Cornell........	401 Eng. Bldg...	11–12	5	11
Sub-freshmen......	Ag. & W. geom......	Math. 2a......	Mr. Johnson........	12 College Hall..	9–10	5	17
Sub-freshmen......	Ag. & W. geom......	Math. 2a......	Mr. Johnson........	12 College Hall..	10–11	5	14
Sub-freshmen......	Ag. & W. geom......	Math. 2.......	Mr. Jones..........	302 Eng. Bldg...	9–10	5	14
Sub-freshmen......	Ag. & W. geom......	Math. 2a......	Mr. McVey..........	111 Eng. Bldg...	8–9	5	19
Sub-freshmen......	Ag. & W. geom......	Math. 2a......	Mr. Sobey..........	12 College Hall..	1–2	5	15
Sub freshmen......	M. geom............	Math. 2c......	Mr Hawkes..........	Abbot Hall.....	8–9	5	20
Sub-freshmen......	M. geom............	Math. 2c......	Mr. Johnson........	12 Colleg Hall..	11–12	5	17
Sub freshmen......	M. geom	Math. 2c......	Mr Rosenberg.....	203 Eng. Bldg...	8–9	5	17
Sub-freshmen......	M. geom............	Math. 2c......	Mr. Wendt..........	401 Eng. Bldg...	10–11	5	16
Sub-freshmen......	Mensuration.........	Math. 3.......	Dr. Gundersen	2 College Hall...	3–4	5	18
Sub-freshmen......	Mensuration.........	Math. 3.......	Prof. Hadden......	203 Eng. Bldg...	3–4	5	18
Sub-freshmen......	Mensuration.........	Math. 3.......	Mr. Hawkes........	Abbot Hall.....	8–9	5	20
Sub-freshmen......	Mensuration.........	Math. 3.......	Mr. Rosenberg.....	203 Eng Bldg...	9–10	5	17
Freshmen.........	Ag. & W. trig.......	Math. 4a......	Mr. Hawkes........	Abbot Hall.....	10–11	5	15
Freshmen.........	Ag. & W. trig.......	Math. 4a......	Mr, Hawkes........	Abbot Hall.....	3–4	3	20
Freshmen.........	Ag & W. trig.......	Math. 4a......	Mr. Johnson........	12 College Hall..	8–9	3	24
Freshmen.........	Ag. & W. trig.......	Math. 4a......	Mr. Jones..........	302 Eng. Bldg...	....	3	10
Freshmen.........	Ag. & W. trig.......	Math. 4a......	Dr. Slobin.........	8 College Hall...	8–9	3	22
Freshmen.........	Ag. & W. trig.......	Math. 4a	Dr. Slobin.........	8 College Hall...	3–4	3	17
Freshmen.........	M. trig.............	Math. 4b.....	Prof. Babcock.....	2 College Hall...	11–12	5	18
Freshmen.........	M. trig.............	Math. 4b.....	Prof. Babcock.....	2 College Hall...	2–3	5	19
Freshmen.........	M. trig.............	Math. 4b.....	Dr. Gundersen.....	2 College Hall...	1–2	5	17
Freshmen.........	M. trig.............	Math. 4b.....	Mr. Jones..........	302 Eng. Bldg...	8–9	5	18
Freshmen.........	M. trig.............	Math. 4b.....	Mr. Rosenberg.....	203 Eng. Bldg...	11–12	5	16
Freshmen.........	M. trig.............	Math. 4b.....	Mr. Rosenberg.....	302 Eng. Bldg...	2–3	5	14
Freshmen.........	M. trig.............	Math. 4b.....	Dr. Slobin.........	8 College Hall...	10–11	5	17
Sophomore........	Integ. Cal...........	Math. 6b.....	Dr. Gundersen.....	401 Eng. Bldg...	8–9	5	12
Sophomore........	Integ. Cal...........	Math. 6b.....	Dr. Gundersen.....	401 Eng. Bldg...	9–10	5	7
Sophomore........	Integ. Cal...........	Math. 6b.....	Mr. Jones..........	302 Eng. Bldg...	11–12	5	17
Sophomore........	Integ. Cal...........	Math. 6b.....	Mr. Jones..........	302 Eng. Bldg...	1–2	5	18
Sophomore........	Integ. Cal...........	Math. 6b.....	Dr. Slobin.........	8 College Hall...	11–12	5	20
Sophomore........	Integ. Cal...........	Math. 6b.....	Dr. Slobin.........	8 College Hall...	1–2	5	16
Sophomore........	Surveying (class)....	C. E. la.......	Prof. Vedder......	117 Eng. Bldg...	8–9	2	65
Sophomore........	Surveying (field).....	C. E. 1a......	Mr. Fuller Mr. McVey	306 Eng. Bldg...	10–12	2	33
Sophomore........	Surveying (field).....	C. E. 1a......	Mr. Fuller Mr. Johnson ...	203 Eng. Bldg...	1–3	2	32
Sophomore........	Surveying (class)....	C. E. 1b......	Mr. Fuller.........	203 Eng. Bldg...	10–11	2	19
Sophomore........	Surveying (class)....	C. E. 1b......	Mr. Fuller.........	203 Eng. Bldg...	10–11	2	22
Sophomore........	Surveying (class)....	C. E 1b......	Mr. McVey.........	109 Eng. Bldg...	2–3	2	25
Sophomore........	Surveying (class)....	C. E. 1b......	Mr. McVey.........	109 Eng. Bldg..	2–3	2	26
Sophomore........	Surveying (field)) ...	C. E. 1b......	Mr. Fuller Mr. Cornell ...	....	8–10	4	19
Sophomore........	Surveying (field).....	C. E. 1b......	Mr. Cornell Mr. Fuller ...	....	8–10	4	22
Sophomore........	Surveying (field).....	C. E. 1b......	Mr. Fuller Mr. McVey	111 Eng. Bldg...	3–5	4	25
Sophomore........	Surveying (field).....	C. E. 1b......	Mr. Cornell Mr Fuller	111 Eng. Bldg...	3–5	4	26
Juniors...........	Str. of Mat..........	Math. 7c......	Prof. Babcock.....	2 College Hall...	8–9	5	11
Spring term.							
Juniors...........	Str. of Mat..........	Math. 7c......	Prof. Babcock.....	2 College Hall...	9–10	5	12
Juniors...........	Str. of Mat..........	Math. 7c......	Mr. McVey.........	109 Eng. Bldg...	9–10	5	10
Juniors...........	Str. of Mat..........	Math. 7c......	Mr. Polson.........	109 Eng. Bldg...	8–9	5	27
Juniors...........	Surveying (class)....	C. E. 6........	Prof. Vedder......	111 Eng. Bldg...	11–12	3	36
Juniors...........	H. Surveying (field)..	C. E. 6........	Mr. Cornell Mr. Wendt	109 Eng. Bldg...	2–5	6	33
Juniors...........	Astronomy..........	C. E. 14......	Dr. Gundersen	109 Eng. Bldg...	2–5	2	28
Seniors...........	H. Surveying (class)..	C. E. 6........	Mr. Cornell........	109 Eng. Bldg...	10–11	3	27
Seniors...........	H. Surveying (field)..	C E. 6........	Mr. Cornell Mr. Wendt	109 Eng. Bldg...	2–5	6	27

Class work of the department of mathematics and civil engineering.—Concluded.

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week.	No. of students in class.
Seniors	Masonry & arches	C. E 9	Prof. Hadden	304 Eng. Bldg	8–10	8	10
Seniors	Masonry & arches	C E. 9	Mr. Wendt	306 Eng. Bldg	8–10	8	12
Seniors	Pavements	C. E. 10	Prof. Vedder	111 Eng. Bldg	10–11	2	31
Seniors	Thesis	C. E. 11	Prof. Vedder	105 Eng. Bldg		10	26
Seniors	Contracts & Specifications	C. E. 13	Prof. Vedder	111 Eng. Bldg	10–11	2	25
Seniors	Road construction	C. E. 17	Prof. Hadden	105, 104 Eng. B.	10–11	8	13
Seniors	Road construction	C. E. 17	Prof Hadden	105 Eng. Bldg	11–12	2	13

The following text books have been used in our classes during the year: Allen's Railroad Curves and Earthwork; Merriman and Jacoby's Roofs and Bridges, Vols. I, II, III; Hodgman's Land Surveying and Vedder's Notes on Surveying; Church's Mechanics; Tanner & Allen's Analytic Geometry; Beeman & Smith's Academic Algebra for all beginning classes formed by women and agricultural students; Well's Text Book in Algebra for engineering students; Wentworth's Geometry; Young's Elements of Astronomy; Murray's Differential Calculus; Ashton and Marsh's Trigonometry; Beeman & Smith's Higher Arithmetic; Baker's Masonry Construction; Johnson's Theory and Practice of Surveying; Jone's Logarithm Tables; Waddel & Wait's Specifications and Contracts; Baker's Roads and Pavements.

The total expenditure by the department during the year for all purposes has been $4,405.43 of which $144 was turned in for special examinations.

Respectfully submitted,
H. K. VEDDER,
Prof. Mathematics and Civil Engineering.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING.

President J. L. Snyder:

Dear Sir—The past year has been one of financial stringency so that the department has made strenuous efforts to avoid going backward. Not very much equipment has been added during the past year. Owing to the fact that our senior electrical engineering class has existed for the first time it made it quite difficult as we had not the equipment for alternating current laboratory work which we should have had, also in the spring term the work in physics had to be modified from that called for by the schedule as we had not sufficient teachers to carry out the program. The agricultural and women freshmen did not take laboratory work but occupied equivalent time with recitation work instead.

During the past year there have been in the department Mr. W. L.

Lodge, Mr. C. W. Chapman, Mr. W. E. Laycock, and since the first of January Mr. H. E. Marsh, teaching physics; Mr. E. N. Bates and myself have had the work in electrical engineering. Mr. E. N. Bates has resigned and Mr. G. A. Kelsall has been engaged to take his place. Mr. C. W. Chapman has also resigned and it will be necessary to secure some one to take his place before the next school year. The members of the department have all made exceptional effort to carry the work in a manner that has been very satisfactory. I am very much pleased with the spirit shown by the men of the department.

Below is a table showing the work carried by this department during the year.

Class.	Subject.	Instructor.	Sections for lectures.	Sections for recitations.	Sections for laboratory.	Hours per week.	Number of students.
Fall term. Sub-freshmen	E. Physics 2a	Mr. Laycock	....	4	....	4	81
Sophomores	E Physics 2d	Mr. Lodge	2	4	8	2 2 2	98
	A. Physics 1e	Mr. Chapman	1	4	4	2 2 2	41
	W. Physics 3c	Mr. Lodge	1	1	3	1 2 4	37
Juniors	E. E. 1a	Mr. Bates	1	....	2	1 4	32
	E. E. 4a	Mr. Bates	....	1	4	1 2	32
Seniors	E E. 2a	Prof. Sawyer	....	1	....	3	29

Class.	Subject.	Instructor.	Sections for lectures.	Sections for recitations.	Sections for laboratory.	Hours per week.	Number of students.
Winter term. Sub-freshmen	E. Physics 2b	Mr. Laycock	1	4	6	1 1 2	81
	W. Physics 3a	Mr. Chapman	1	2	3	1 3 2	52
	A. Physics 1a	Mr. Marsh	1	4	4	1 3 2	67
Sophomores	E. Physics 2e	Mr. Lodge	2	4	8	2 2 2	87
	A. Physics 1f	Mr. Chapman	1	4	4	2 2 2	41
Juniors	E. E. 1b	Prof. Sawyer	....	1	....	3	26
	E. E. 4b	Mr. Bates	....	1	4	1 2	26
Seniors	E. E. 2b	Prof. Sawyer	....	1	....	5	22
		Mr. Bates	....	....	2	4	22
	E. E. 5a	Mr. Bates	....	1	3	5 4	10

Class.	Subject.	Instructor.	Sections for lectures.	Sections for recitations.	Sections for laboratory.	Hours per week.	Number of students.
Spring term.							
Sub-freshmen	E. Physics 2c	Mr. Laycock	1	4	4	1 2 2	81
	W. Physics 3b	Mr. Laycock	1	2	3	1 3 2	52
	A. Physics 1b	Mr. Marsh	1	4	4	1 3 2	58
Freshmen	W. Physics 3d	Mr. Chapman	1	4	....	1 2	120
	A. Physics 1d	Mr. Chapman	1	6	....	1 2	35
Sophomores	E. Physics 2f	Mr. Lodge	2	4	8	2 2 2	87
Juniors	E. E. 1c	Prof. Sawyer	....	1	....	4	26
		Mr. Bates	....	....	4	3	26
Seniors	M. E. 6f	Prof. Sawyer	....	....	1	6	11

Carhart's University Physics, volume one and volume two has been used pretty generally for the advanced classes in physics. Mr. Chapman, however, this spring used Reed's which he considers better adapted for the agricultural students as it contains less mathematics than Prof. Carhart's book. In the electrical engineering classes we have found Prof. Karapetoff's Elements of Experimental Electrical Engineering very satisfactory for much of our laboratory work. Franklin and Estey's book, volume one, is used by juniors in direct current work, while Sheldon, Mason and Hausmann's book, volume two, on alternating currents has been used by the seniors.

Due to the rearranging of the engineering classes which has been in progress for the last two years all engineering juniors will take some electrical work hereafter so that the work of the department will be somewhat increased next fall and winter term. It seems to me this is much to be desired as all engineering students come in contact more or less with the application of electricity in commercial work.

Respectfully,
A. R. SAWYER,
Professor of Physics and Electrical Engineering.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF DRAWING AND DESIGN.

President J. L. Snyder:

Dear Sir:—In submitting this, my first annual report as head of the Department of Drawing and Design, I wish to preface it by reference to my friend, the late Professor W. S. Holdsworth.

There has been an element of sadness to me in the discharge of my duties this year in the thought that I was called to carry on his work. I saw at once that I was taking up the work of a master hand and I cannot refrain here from expressing my appreciation of him as a teacher and organizer. If I can succeed in carrying out his plans as he would have done, I feel that I shall be doing the best work for the college. The esprit de corps of the staff of instruction has been all that could be desired and also bears testimony to his efficiency.

With Professor Chace Newman, so capable and so familiar with the details of administration, I was assisted very materially in my work, and enabled to continue the policies of Professor Holdsworth. The department work has been carried on this year with the aid of the following teachers: Prof. Chace Newman, Miss Caroline Holt, Mr. C. H. Harper, Miss Isabel Snelgrove, Mr. N. P. Pope, Mr. C. C. Cobb, named in the order of seniority of appointment. The responsibilities were divided into those of the free-hand drawing under Miss Holt, the civil engineering drawing under Mr. Harper, and other mechanical drawing under Professor Newman.

Miss Holt assumed entire charge, as heretofore, of the free-hand drawing, and the supervision of Miss Snelgrove in her classes. She also continued the courses in the history of art, that to the sophomore women being slightly modified into the history of design. She is taking a course in the summer school of the Teacher's College in New York City in order to better fit her for her duties.

Miss Snelgrove was secured for two terms' work, the heaviest in the free-hand drawing. A graduate of Olivet College, she began her teaching experience with us and succeeded so well that it was decided she be retained on the staff the next year. She is now continuing her art studies in Chicago.

Mr. C. H. Harper, an exceedingly trusty and capable instructor, leaves us at the end of this year, much to our mutual regret, to accept higher salary elsewhere.

An instructor by the name of Mr. C. H. Eiffert, appointed in the fall, left us suddenly at the Christmas holidays to accept higher salary in practical work; Mr. N. P. Pope succeeded him and completed the year very satisfactorily.

Mr. C. C. Cobb, who had served the previous year, continued as an extra assistant, teaching six hours per week throughout the year. He has been appointed an instructor on the regular staff for the next year, having graduated in June.

As stated, the courses have been carried on essentially as Professor Holdsworth had organized them, only some minor changes being made.

Descriptive geometry was changed to both a recitation and laboratory subject, one recitation and two drawing periods per week.

With the steady increase in attendance and the diversified interests of the students taking work, it seems likely that the Drawing Department could, to advantage, increase its sphere of usefulness by broadening its courses to include industrial drawing and design. The change of the course in history of art to history of design, a step in this direction, met with great favor and seems to justify the assumption that such a change in the courses offered would be welcome.

A new departure, undertaken experimentally this year, was to hold an exhibition of public school drawings at the time of the Interscholastic Meet, May 13th to 15th, inclusive. This was done under the conviction that it is the function of the college departments to cooperate with the educational interests of the state. The exhibition proved very successful, considering everything, some fifteen cities of the state sending exhibits, including Detroit and points as far away as Houghton and Marquette. It was visited by large numbers and proved, incidentally, to be quite an inspiriation to our own students. The expense was not great and it is hoped that it may become an annual event and an occasion of increasing interest as time goes on.

Following are some tables which show the distribution of the students among the different classes, and the instructors:

Fall term drawing classes, 1908.

Class.	Subject.	Instructor.	Number section.	Hours per week.	Students in classes.
Sub-freshmen	1. Free-hand drawing	Miss Snelgrove	I	2	39
Sub-freshmen, Ag	1. Free-hand drawing	Prof. Newman	I	2	37
Sub-freshmen, Ag	1. Free-hand drawing	Prof. Wilson	II	2	37
Sub-freshmen, Eng	4a. & 4c. F. H. & Mech. drawing.	Prof. Wilson	I	6	20
Sub-freshmen, Eng	4a. & 4c. F. H. & Mech. drawing.	Mr. Cobb	II	6	19
Sub-freshmen, Eng	4a. & 4c. F. H. & Mech.drawing.	Mr. Eiffert	III	6	18
Sub-freshmen, Eng	4a. & 4c. F. H. & Mech. drawing.	Mr. Harper	IV	6	21
Freshmen, Ag	1c. Free-hand drawing	Miss Snelgrove	I	4	37
Freshmen, Ag	1c. Free-hand drawing	Miss Snelgrove	II	4	31
Freshmen, Ag	1c. Free-hand drawing	Miss Holt	III	4	29
Freshmen, Ag	1c. Free-hand drawing	Miss Holt	IV	4	35
Freshmen, W	1b. Free-hand drawing	Miss Holt	I	6	43
Freshmen, W	1b. Free-hand drawing	Miss Snelgrove	II	6	40
Freshmen, Eng	4a. & 4b. F. H. & Mech. drawing.	Mr. Eiffert	I	6	28
Freshmen, Eng	4a. & 4b. F. H. & Mech. drawing.	Prof. Newman	II	6	33
Freshmen, Eng	4a. & 4b. F. H. & Mech. drawing.	Mr. Eiffert	III	6	31
Freshmen, Eng	4a. & 4b. F. H. & Mech. drawing.	Prof. Newman	IV	6	27
Sophomores, Eng	5b. Desc. geometry	Prof. Wilson	I	6	25
Sophomores, Eng	5b. Desc. geometry	Mr. Harper	II	6	28
Sophomores, Eng	5b. Desc. geometry	Prof. Newman	III	6	26
Sophomores, Eng	5b. Desc. geometry	Mr. Eiffert	IV	6	22
Sophomores, W	1e. Charcoal drawing	Miss Holt	I	4	4
Juniors, Eng	6. Topographical drawing	Mr. Harper	I	6	16
Juniors, Eng	6. Topographical drawing	Mr. Harper	II	6	20
Totals			XXIV	122	666

Six instructors, full time; one instructor, six hours per week.

Winter term drawing classes, 1909.

Class.	Subject.	Instructor.	Number section.	Hours per week.	Students in classes.
Sub-freshmen, Ag	1a. Free-hand drawing	Prof. Wilson	I	2	33
Sub-freshmen, Ag	1a. Free-hand drawing	Miss Snelgrove	II	2	35
Sub-freshmen, W	1a. Free-hand drawing	Miss Snelgrove	I	2	40
Sub-freshmen, Eng	4d. Mech. drawing	Mr. Cobb	I	6	8
Sub-freshmen, Eng	4d. Mech. drawing	Mr. Pope	II	6	20
Sub-freshmen, Eng	4d. Mech. drawing	Mr. Pope	III	6	20
Sub-freshmen, Eng	4d. Mech. drawing	Mr. Harper	IV	6	18
Freshmen, W	1d. Charcoal drawing	Miss Holt	I	4	20
Freshmen, W	1d. Charcoal drawing	Miss Snelgrove	II	4	22
Freshmen, W	1d. Charcoal drawing	Miss Holt	III	4	20
Freshmen, W	1d. Charcoal drawing	Miss Snelgrove	IV	4	16
Freshmen, Eng	4e. Mech. & Mach. drawing	Mr. Harper	I	8	27
Freshmen, Eng	4e. Mech. & Mach. drawing	Prof. Newman	II	8	35
Freshmen, Eng	4e. Mech. & Mach. drawing	Mr. Harper	III	8	27
Freshmen, Eng	4e. Mech. & Mach. drawing	Mr. Pope	IV	8	25
Juniors, W	2b. History, Art, Elective	Miss Holt	I	5	17
Juniors, Eng	7. Shades, shadows & prospective	Prof. Newman	I	8	17
Juniors, Eng	7. Shades, shadows & prospective	Prof. Wilson	II	8	18
Totals			XVIII	99	418

Six instructors, full time; one instructor, six hours per week.

Spring term drawing classes, 1909

Class.	Subject.	Instructor.	Number section.	Hours per week.	Students in classes.
Sub-freshmen, Eng	4f. Mach. drawing	Mr. Pope	I	6	27
Sub-freshmen, Eng	4f. Mach. drawing	Prof. Newman	II	6	35
Freshmen, Eng	5a. Desc. geometry	Mr. Harper	I	6	30
Freshmen, Eng	5a. Desc. geometry	Prof. Newman	II	6	29
Freshmen, Eng	5a. Desc. geometry	Mr. Cobb	III	6	27
Freshmen, Eng	5a. Desc. geometry	Mr. Pope	IV	6	30
Freshmen, Eng	5a. Desc. geometry	Prof. Wilson	V	6	27
Freshmen, Eng	5a. Desc. geometry	Mr. Harper	VI	6	15
Sophomores, Ag	3b. Mech. drawing	Prof. Wilson	I	6	28
Sophomores, Ag	3b. Mech. drawing	Mr. Pope	II	6	25
Sophomores, W	3a. Mech. drawing	Miss Holt	I	4	18
Sophomores, W	3a. Mech. drawing	Miss Holt	II	4	21
Sophomores, W	2a. History Art	Miss Holt	I	3	39
Juniors & Seniors, F., Ag. W.	3c. Topographical drawing	Mr. Harper	I	10	14
Totals			XIV	81	375

Five instructors, full time; one instructor, six hours per week.

Table showing increase of student hours.

Year.	Term.	Instructors.		Sections.	Total hours per week.	Total students for term.
		Full time.	Part time.			
1901	Fall	3		12	54	227
1902	Winter	3		14	76	267
1902	Spring	3		6	30	133
1902	Fall	3	1 (1 sec.)	16	67	449
1903	Winter	3		11	73	302
1903	Spring	3		8	44	191
1903	Fall	3	1 (1 sec.)	14	69	515
1904	Winter	3	2 (2 sec.)	12	68	349
1904	Spring	3	1 (2 sec.)	12	52	294
1904	Fall	4		13	63	391
1905	Winter	4		12	64	342
1905	Spring	4		13	69	239
1905	Fall	4		14	64	358
1906	Winter	4		11	78	267
1906	Spring	4		8	41	195
1906	Fall	4		11	59	240
1907	Winter	4		12	87	310
1907	Spring	3	1	9	47	227
1907	Fall	4	3	19	94	542
1908	Winter	4	3	18	115	445
1908	Spring	4	1	11	68	258
1908	Fall	6	1	24	122	666
1909	Winter	6	1	18	99	418
1909	Spring	5	1	14	81	375

The last table is given to show the rate of increase and decrease of the students receiving instruction in the department for the past eight years. There has been fluctuation but a total gain from the beginning of 130 per cent. And in this connection, it is significant to note that the instructional force has hardly kept pace with the general increase; although but slightly behind it. The department has now two of professor or assistant professor grade and four of instructor grade. With moderate increase, the addition of an instructor or two will probably be adequate to properly care for the work.

Very respectfully sumbitted,
VICTOR T. WILSON,
Professor of Drawing and Design.

East Lansing, Mich., June 30, 1909.

REPORT OF WOMEN'S DEPARTMENT.

To the President:

Dear Sir:—The year just closed showed an enrollment in the Women's department of two hundred thirty-two women, which necessitated the use of two outside houses for rooms. Class rooms and laboratories have been crowded also, although the large incoming classes required a division of sections and increased teaching force.

Miss Kate M. Coad, a graduate of the class of 1905, was secured as senior instructor in charge of domestic art. Miss Coad had taken additional courses in the University of Chicago and has built up the work in this department very successfully. During the summer of 1908, Miss Chapman tendered her resignation, but fortunately for us she returned for the first few weeks of the year to assist in the work of organizing and classification of new students. Her successor, Miss Mable Long, a graduate of the New Haven Physical Training School, was necessarily late in arriving but has been a very efficient worker.

Our teaching force, with average number of hours per week, has been as follows: Miss Freyhofer, musical director and director of the college choir, 21; Miss MacDonald, domestic science and steward of department dining room, 10; Miss Coad, domestic art, 20; Mrs. Peppard, domestic art and domestic science, 22; Miss Kedzie, domestic art (giving half time only), 15; Miss Long, physicial training and health officer, 15; Miss Hopson, music, 21; Mrs. Georgia Woodman, music (fall and winter only), 10; Mrs. Martha Barber, home nursing (fall term only), 2.

The experience of the past year with special students confirms the opinion formed before, that until we can maintain a special course in Home Economics of one or two years, it is unwise to continue the present policy of admitting specials. The last catalog makes this definite statement, "Unless conditions are exceptional each applicant is expected to enroll as a regular student." Adherence to this rule is the part of wisdom for the present.

The dean of the department has made several trips during the last half of the year, by invitation, usually of Women's Clubs, to present to the high school girls and their mothers the work of the department. It is evident that the women of the state are unaware of the scope of the opportunities afforded. We need the enlightened interest and co-operation of the great body of Michigan women to carry on the work that is possible at this institution.

Respectfully submitted,
MAUDE GILCHRIST,
Dean of the Women's Department.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

President J. L. Snyder,
E. Lansing, Michigan.

Dear Sir—According to the custom I herewith present my report of the Chemical Department for the current year:

The accompanying schedule shows the classes held and the number of students registered in each class.

FALL TERM, 1908.

Classes.	No. of students.	
General Chemistry:		
Engineers (Freshmen)	183	
Agricultural and Forestry (Freshmen)	133	
Women (Sophomores)	43	
		359
Organic Chemistry:		
Agricultural (Sophomores)	76	76
Total		435

WINTER TERM, 1909.

Classes.	No. of students.	
Mineralogy, Chemistry 5a (Freshmen)	162	
Qual. Anal., women—Chemistry 2 (Freshmen)	40	
Qual. Anal., men—Chemistry 2 (Freshmen)	130	
Agricultural Chemistry 4 (Junior elective)	33	
Dairy Chemistry, Ag. 11c, (Senior elective)	9	
Total		374

SPRING TERM, 1909.

Classes.	No. of students.	
Engineering Chemistry 5b (Freshmen)	170	
Quant. Anal., Chemistry 5 (Senior elective)	16	
Domestic Science Chemistry 4, women (Senior elective)	12	
Animal Nutrition, Ag. 5a (Senior elective)	14	
Organic Chemistry 3, women (Sophomores)	33	
Total		245

In addition to the work with the regular college students above scheduled a series of twenty-four lectures was delivered during the first eight weeks of the winter term to a class of eighty-five short course students on simple chemistry of the farm. At the close of the course a brief review and an examination was given.

The average number of students per term doing laboratory work and receiving instruction was 350. To do this necessitated so far as lectures are concerned, a repetition of the work in General Chemistry, the same lecture of necessity being given three times. The number of lectures in General Chemistry was cut from five to three per week and in place of the two lectures thus omitted a quiz hour was held which I found has been of much benefit to the students. The year 1908-1909 has given us the largest number of students to handle and indicates very clearly to us that the limit of capacity of the laboratory has practically been reached. Therefore during the next two years arrangements must be made for increasing the capacity of the laboratory. To do this I recommend that the south portion of the building be added to, both on the east and on the west sides affording additional laboratory and lecture room space. Our largest lecture room now accommodates but 150 students. We should have one which would readily accommodate 250. The laboratory building while old is still entirely serviceable and I think that the additions can be made to it with safety and economy. These additions, however, should not be of the nature of a third story in my judgment.

The usual amount of investigational work for various citizens of Michigan has been carried out and reported upon including many samples of water, soils, fertilizers, feeding stuffs and various articles of commercial interest.

During the year just closed the staff of the department has been composed as follows:

Assistant Professor: H. S. Reed.

Instructors: A. J. Clark, W. H. Parker, T. W. Mason and J. Wershow.

Stenographer: E. A. Goodhue.

Caretaker: Geo. Churchill.

The assistance of all these I especially desire to acknowledge.

Respectfully submitted,
FRANK S. KEDZIE,
Professor of Chemistry.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

Sir—I have the honor to submit herewith the annual report of the Department of Zoology and Physiology for the year ending June 30, 1909.

There have been two changes in the teaching force of the department since my last report. Mr. J. R. Kelton, who had served very acceptably as instructor in zoology for two years and had been reappointed for a third year, resigned during the summer vacation in order to accept a much more lucrative position elsewhere, and Mr. Lee W. Harrington, a recent graduate of the University of Michigan, who came highly recommended, was selected to fill the vacancy. During the fall term it became evident that the work of the department was entirely too heavy for an instruction corps of but three men, and an additional instructor, Mr. B. B. Roseboom, a recent graduate of Hamilton College, N. Y., was employed at the beginning of the winter term and continued until the end of the year. His work proved satisfactory and he has been retained for the coming year. A student assistant, Mr. Glenn A. Gilbert, was also employed during the spring term at department expense.

Even with this addition, however, the department is not able to keep its work up to the standard of efficiency formerly maintained, and at least one more regular assistant must be added to the teaching force this fall. I would also renew my request of last year for the employment of a museum assistant and preparator, without which it will be quite impossible to keep up the museum collections and make them fairly useful to the students and to the general public. Such an assistant would not only save us most of the small expenses now incurred for the mounting of local specimens, but would enable us to enlarge our Michigan collections and make them measurably complete, which in my opinion is one of the most important functions of such a museum.

An examination of the following schedule of classwork for the past year will show the basis for the statements just made as to the teaching work of the department.

Schedule of class work, 1908-1909.

Term.	Subject.	Course.	Class.	Number students.	Instructor.
Fall	Geology 1a	Agriculture, Forestry	Sophomore	70	Barrows. Myers.
Fall	Geology 1a	Agriculture, Forestry	Junior and Senior	27	Harrington.
Fall	Geology 1b	Home Economics	Sophomore	30	Barrows, Myers.
Fall	Physical Geography 1a	Agriculture, Forestry	Sub-freshmen	72	Myers, Harrington.
Fall	Physical Geography 1b	Home Economics	Sub-freshmen	34	Harrington, Myers..
Fall	Zoology 1b	Home Economics	Junior.	11	Myers, Barrows.
Winter	Anatomy 1a	Agriculture, Forestry	Sophomore	69	Myers, Harrington, Roseboom.
Winter	Anatomy 1b	Home Economics	Sophomore	32	Myers, Roseboom.
Winter	Zoology 2a (Embryology).	Agriculture, Forestry	Junior and Senior	26	Barrows, Myers.
Winter	Geology 2a	Agriculture, Forestry	Senior	6	Barrows.
Spring	Zoology 1a	Agriculture, Forestry	Freshmen	129	All instructors.
Spring	Zoology 1b	Home Economics	Freshmen	67	All instructors.
Spring	Zoology 3a	Agriculture, Forestry	Junior and Senior	25	Barrows, Myers, Harrington.
Spring	Zoology 3b	Home Ecomomics	Junior and Senior	11	Barrows, Myers.
Summer	Ornithology	Summer school	Normal Teachers	10	Barrows.
Total number of students				619	

The number of students handled during the college year of 1907-1908 was 370, the number in 1908-1909, 619, or an increase of more than 67 per cent, while the teaching force was only increased from three to four, or 33 per cent.

This large increase in the number of students is in part due to the larger entering classes, but also to the transfer of the sophomore zoology (Zoology 1a and 1b) to the freshman year, a change which, as noted last year, was made against the protest of the department, and has proved to be unfortunate in more than one respect. It is greatly to be hoped that whatever may be the place assigned to elementary anatomy and physiology in the future, the zoology may follow instead of preceding it as at present. I would also urge most earnestly that in the courses in agriculture and forestry, at least two full terms of zoology (exclusive of entomology) be required, together with two full terms of mineralogy and geology. No amount of elective work in the junior and sophomore years can take the place of the foundation work in the sciences, and the present amount and arrangement of this science work, in my opinion, is far from yielding the best results.

As a natural consequence of the large increase in the number of students and the attendant multiplication of sections for laboratory work, our quarters are now altogether too small and it will be necessary to find class and laboratory rooms elsewhere for one or more subjects. During the coming fall term the classes in physical geography probably will be held in the new agricultural building if suitable rooms there are finished in time, but before another year it is extremely desirable that a laboratory specially equipped for work in mineralogy (including blowpipe analysis) and geology be provided. At present it is necessary sometimes to use the same rooms on the same days for anatomical zoological and geological work, thus entailing a large amount of rapid shifting and rearranging of apparatus and material, with considerable loss of time and a necessarily high percentage of wear and tear on the equipment.

It is a pleasure to be able to record the fact in this connection that in spite of the heavy work and long hours all the members of the department have shown commendable zeal in the performance of their several duties, and almost without exception deserve the highest praise for successful work. Making due allowance for the magnitude of the work and the difficult conditions under which some of it had to be done, it may be safely said that the results have exceeded the most sanguine expectations.

Respectfully,
WALTER B. BARROWS,
Professor of Zoology and Physiology and Curator of the General Museum.
East Lansing, June 30, 1909.

REPORT OF THE DEPARTMENT OF HISTORY AND ECONOMICS.

To the President:

I have the honor of submitting the following report concerning the Department of History and Economics for the year 1908-9.

The total number of enrollments in this department during the year was 1,618, distributed as follows:

By terms. Fall 394; winter 711; spring 513.

By classes. Sub-freshmen 222; freshmen 657; sophomores 303; juniors 225; seniors 103.

By subjects. History 773; Economics 653; "Education" 16; Political Science 118; Sociology 38.

The total number of hours taught during the year was 2,470 divided among the three terms as follows:

Fall 622; winter 948; spring 900.

By subjects. The number of recitation hours during the year equalled in History 1,272; in Economics 828; in Education 60; in Political Science 240 and in Sociology 60.

A new teacher, Mr. Hector MacPherson, was added to our teaching staff during the year and another, Mr. Shepherd Leffler, was appointed to take the place of Mr. McAlvey, who resigned at the beginning of the year—otherwise the personnel of the department has remained unchanged.

The subject of Sociology, under the care of Mr. MacPherson, was taught for the first time at this college during the spring term. An agitation has been under way for some time among the various agricultural colleges toward encouraging the study of the social surroundings of the farmer. None of these institutions have wholly neglected the business aspect of the farmer's life and courses in Economics have been given in these schools from the very beginning. Indeed in recent years the suitability of such courses to these schools has become so apparent that they have became highly technical and courses in agricultural economics may now be found in the curricula of many colleges and universities. On the other hand other institutions while presenting no formal courses entitled"Agricultural Economics" use illustrative material drawn from farming in presenting elementary economics and emphasize the aspects of the subject which deal with the interests of the farmer.

But rural sociology is of more recent origin and is presented at present in only a few schools. It aims to acquaint the country dweller with his proper relations to the church, the school, the community and the community organizations. The questions of pauperism, vagrancy and of crime are of no less significance to the farmer than to the city dweller though it is a remarkable fact that the investigations of most sociologists have hitherto been confined largely to the study of these questions from the city standpoint. The study of Sociology is commenced therefore at this place under the conviction that it offers something very useful to the future agriculturalist.

President Roosevelt urged the especial attention of the Rural Life Commission, which he recently appointed, to the phases of farm life which had to do with the social or community side and the whole subject has been much advanced by the treatises recently published by two members of this commission. The treatises are entitled Chapters in Rural Progress, and the State and the Farmer and are written by President Butterfield and Director Bailey respectively.

No departmental problem has been so pressing for solution during the past year as has that of the proper distribution of teaching hours to members of the department. The problem is all the more difficult too, because of the laws of established rule at this place which govern such matters, and a rule of the sort needed has been of slow development through the extreme variations among the various departments as to laboratory or class work, lecturing or text-book teaching and as to the amount of general or departmental work for which members of the department are responsible. The nature of the subject presented too, causes important variations. Mathematics an "exact science" for example, and grammar do not change appreciably in subject matter from year to year while many of the other sciences are so unceasingly reshaped by growth that one who teaches them must periodically relearn his subject matter.

Economics, Political Science and Sociology are studies in this department which answer to the description just given and the teachers of all of these subjects find their material differing widely from year to year. This variableness in material makes the lecture method of presenting these studies almost unavoidable and a species of informal or conversational lectures supplemented by quizzes from a text-book has proven the best way for teaching these subjects at this college. This method of teaching is further dictated by the fact that the students to whom this work is given are properly advanced students—juniors and seniors—and therefore are not only capable of benefitting from the lecture method but also fairly exact something more than mere text book routine from their teachers.

Under the circumstances of presenting the courses in this department in the way which has been described, it has long been found that fifteen hours per week is the very maximum of time that an instructor can efficiently teach these subjects to such students and it is highly probable that by shortening this time the instruction would be sufficiently improved in quality to more than equal the diminished quantity. It is much to be hoped that some settled policy may soon develop which will properly determine the constituents of a day's work for college teachers. It seems timely for many reasons to enlarge here upon the inquiry as to which of the two kinds of economics, to which reference was made in a preceding paragraph, should be taught at agricultural and engineering colleges. The place of economics as a cultural study in the curriculum of the modern college seems assured since it affords similar materials for teaching purposes as that furnished by any other science. But it seems demonstrable that it is the practical usefulness of the subject in these days of insistent economic problems, class strivings and social questions which has caused within a decade the manifold additions to the economic courses offered in our colleges and universities. College students are interested in these matters and want to understand the principles and forces which govern economic matters. The problem of selection becomes indeed an ardous one to the college instructor when confronted with the task of choosing the three or four phases of economics which he is allowed to present from the seventy or more now offered by the modern university.

The selection at an engineering and agricultural college, however, is commonly limited to a choice between specialized phases of economics which bear closely upon agriculture or engineering as the more general and elementary features of the subject. At this college the choice has been made in favor of the general presentation both because of the greater disciplinary value from the better elaborated elementary principles and also because it is believed that the future agriculturalist or engineer should be interested and instructed in social problems as a citizen and member of society first and foremost, rather than as a mere technicist. The question is the same with economics as it is with any of the other sciences which have useful applications: should the science come first in class room presentation and the practical features later, or should the order be reversed. It is much to be feared that in many college schemes of study in which courses in agricultural and engineering economics predominate to the exclusion of all others along social lines, that the presentation must be largely dogmatic.

The utmost praise is due to the assistant members of this department for the fidelity and industry with which they have done the work which has fallen to them. Mr. Ryder has been relieved from teaching the subjects pertaining to the course in "Education" through the establishment of the department of education and will henceforth give his entire time to history and political science. Mrs. Hendrick has been enabled to teach English history almost exclusively throughout the year and the opportunity to specialize in this way must necessarily result in more efficient teaching. No small share of the facility with which this department has handled the largely increased numbers of students who have within the past two years came into its charge, has been due to the willingness of the associate teachers to sacrifice their inclinations and interests for the good of the work.

Respectfully submitted,
WILBUR O. HEDRICK,
Professor of History and Economics.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES.

President J. L. Snyder, East Lansing, Michigan:

My Dear Sir:—The college year 1908-1909, began with the following instructors in my department, of whom the first five had been with us the preceding year: Professor E. S. King, Miss Norma L. Gilchrist, Miss Helen Michaelides, Mr. W. W. Robinson, and Mr. J. C. Paltridge; Mr. C. R. Mann, Mr. A. E. Fish, Mr. P. M. Bauknight, and Mr. Herman Hensel. In January the additional work required of the department by the introduction of the new course for engineers necessitated the securing of Mr. Laurence B. Brink for work in English and Mrs. George A. Robson for three-quarters work in German and English. Mr. Bauknight was compelled by illness to resign the first of April. The department was fortunate in securing an experienced instructor, Mr. Roscoe Gilmore Stott, to take his place. All of these instructors, with the exception of Mr. Mann, now expect to be with us during the ensuing year.

Even with this increased corps of instructors the work of the department has necessitated a schedule which practically filled the time of instructors, making it impossible for them to continue the development of individual instruction for inexpert students. This individual instruction, the vital touch between student and teacher, seems to me to be one of the essentials of effective college work, and I have been exceedingly anxious that in the English Department it might be fully developed. I trust that the coming year will enable us to do far more of this kind of work than has been possible during the past year.

The illness of instructors at various times has added considerably to the burden of those who remained well, it being practically impossible to bring in an assistant temporarily. At one time during the spring term three of our force were away ill, and yet the other instructors carried the work with the omission of scarcely a recitation. The question of illness as the department increases is becoming one of considerable concern. It is almost necessary to carry one more instructor than is normally required in order that the distribution of classes when an instructor is ill may not work unreasonable hardship on those who are blessed with health.

Throughout the year the department has been hampered by lack of recitation rooms. With twelve members the department has at its disposal only three recitation rooms. Additional rooms must be found wherever possible. During the year we have been in every building on the campus containing recitation rooms. For an instructor to look after the details that must follow a recitation and to pass from the Women's Building or the Horticultural Building to the fourth floor of the Engineering Building, within the five minutes between classes, is a physical impossibility; and yet such changes have been required almost every hour during the year. It is hoped that the completion of the Agricultural Building will be accompanied with the assignment to this department of at least three additional rooms to which the department will have primary right. Where these rooms are located is immaterial; but that the demand for them is imperative you will readily see.

During the fall term 1476 students were registered in the study of English; 110 in the study of German; 37 in the study of French.

During the winter term the number of students was as follows: English, 1,357; German, 206; French, 31. During the spring term 1,161 were registered for English; 171 for German; 28 for French. The total number in the fall term was 1,623; in the winter term, 1,594; in the spring term, 1,360. The average total enrollment for the year was 1,526. The average cost of instruction per student in the department was $6.57.

I am still looking forward to a time when we shall be able to introduce into our work in German and French the language phone. I have recently given some additional attention to the use of the talking machine in the teaching of modern languages and I am more than ever convinced that it is desirable. Many of the foremost institutions are using it, and its value is beyond question. With us, its use, however, seems dependent upon rooms; and rooms are lacking.

It is with pleasure that I record the fact that we were again victorious in our intercollegiate debate with Ypsilanti State Normal College. This is the third successive year in which we have won. While the debate for the first time was under the general management of the debating society, the department has necessarily had much to do with the training of the contestants. To Mr. Fish belongs special credit for this work, as to it he gave more time than did any other member of the department. The representatives this year were Mr. C. L. Nash, a senior agricultural student, Mr. J. C. DeCamp, a junior forestry student, and Mr. E. E. Kurtz, a junior engineer. Last year all of the members of the team were junior agricultural students. None of them, however, were candidates for the team this year.

Mr. C. J. Oviatt, student in agriculture, represented the college in our state oratorical contest and Miss Shirley May Gardner represented the college in the state oratorical contest for women. This is the first time we have been represented in the women's contest. Both of these representatives were members of the senior class. Although neither was so fortunate as to win first place, both of them were in every way a credit to the college. Next year this college will entertain the state oratorical contest, and our intercollegiate debate with Ypsilanti will also be held here.

During the winter term a course in oration writing was inaugurated for all sophomore men. Through the courtesy of the Funk and Wagnalls Company a $30.00 copy of the Standard Dictionary was offered as a prize to the member of this class who should prepare and deliver an oration adjudged most worthy of such a prize. Forty men volunteered to contest for this prize, from whom by preliminary contests ten men were selected for the final contest, which was held on June 16. At this contest Mr. George Harris Collingwood, an agricultural student, received the first prize. The second prize, a ten-volume set of the "World's Great Orations," offered by the English Department, was won by Mr. W. R. Walker, an engineering student. For the department and for the college I desire in this public way to express our appreciation of the courtesy of the Funk and Wagnalls Company for the splendid prize which they enabled us to offer in this contest.

We hope to make this sophomore oration contest an annual affair with appropriate prizes. We believe that it will foster and develop oration writing in this college in a way which will be of the utmost value to the young men who do the work.

In the matter of public speaking we feel that our young men are deprived of both incentive and opportunity to an unfortunate degree. Would it not be possible for an arrangement to be made by which students could make brief addresses before Farmers' Institutes, Granges, Farmers' Clubs, etc., making known to the agricultural interests matters of moment in the development of the science of agriculture, as well as matters of practical farm value along the line of engineering science? It seems to me that some work of this kind would be valuable both in giving the young man opportunity and training and also in making known to the world something of the real work of our college. Through the achievements of our students we are known to the world almost exclusively by our athletic teams. I would not for a moment decrease this avenue of interest, but I believe some such additional avenue as I suggest would be of no little value.

In general I believe that the work of the department during the year has become more practical. For the benefit of students who do not spell well, during both the winter and spring terms, a daily class for fifteen minutes was held at an hour available to every student. Special emphasis has been given in the sub-freshmen and freshmen years to the most practical kind of letter writing. In various other ways we are endeavoring to make the department give the kind of training which will make our graduates able to command respect because of their power of oral and written expression. Matters of this kind are often taken for granted in college work in English, and are conse quently not sufficiently emphasized. We hope that in the future we shall be able to give to this side of our work even greater emphasis.

The members of the department who were with us during the college year 1907-1908 came to the work this year with a knowledge of details and conditions which made their work especially valuable. The persons who came into the department for the first time have manifested skill and discernment in mastering the situation and have proven satisfactory teachers. All in all the department was unusually fortunate in securing good teachers in the instructors hired during the past year. For every member of the department force I have only praise. With so many of them returning for the coming year I believe we can do the best work in the history of the department. During the year past every one has striven for the welfare of his students. In the year to come they will strive no less earnestly, and the experience of this year will bring even better returns for their labor. They do not expect thanks, as they have only done their duty. To each, however, I desire to express my sincerest appreciation.

To the State Board for the appropriations made to the department, and to yourself and the other executive officers of the college for unnumbered courtesies of every kind I wish to express the thanks of the department.

Yours most respectfully,
THOS. C. BLAISDELL,
Professor of English and Modern Languages.
East Lansing, Michigan, June 30, 1909.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

President J. L. Snyder:

Following is a brief report of the work done by the Department of Entomology during the year 1908-9.

Six regular courses have been given during the year, besides a course of lectures during the summer school for County Normal teachers and two courses during the winter short term, making nine courses in all.

The addition of a set of wall charts to the equipment has made the work much easier and it is hoped that we may be able to make more of these charts ourselves during the coming year. The collection has grown slowly as has also the permanent equipment in other ways.

During the year Mr. M. A. Yothers has assisted very efficiently as instructor and the writer wishes to extend his personal thanks and appreciation for the same.

Respectfully submitted,
R. H. PETTIT,
Professor of Entomology.
East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF VETERINARY SCIENCE.

Pres. J. L. Snyder, Michigan Agr'l College:

Dear Sir—I have the honor to submit the following report:

During the past college year classes have been conducted in this department much the same as in past years except that the freshmen have been required to take two hours work during the spring term instead of sophomores taking two and one-half hours work during the winter term as before. The work selected for this purpose has been a course of lectures on the conformation and soundness of animals, especially the horse with suggestions for examination of animals at sales.

With the opening of the ensuing school year more room will be available in this building in which I hope to be able to establish a small pharmacy and dispensary in connection with the department wherein drugs required for the treatment of the college stock may be kept in suitable amounts. This would seem advisable when the amount of medicine required annually is considered, and especially so in view of the fact of the necessity oftentimes of immediate attention to such matters which thus far we have not been able to secure. During the past year some additions have been made to laboratory equipment, largely in the nature of operating instruments and securing devices. The budget already submitted, if fully allowed will make possible the completion of this part of the department so far as the demands made upon it are concerned. During the past year the publications belonging to the department have been partially catalogued. This together with the stenographic assistance have been accomplished by student labor and which during the time they could be utilized, has been satisfactory.

The demands made upon this department in correspondence, case reports, etc., requires a more elaborate office equipment than is now possessed and it is sincerely hoped that this may be amply provided for in the next department appropriation. Appropriations for running expenses for the department have been, hitherto, wholly inadequate for the needs of the department and the matter of department traveling expenses is deserving of considerable consideration since there are many instances occurring during each year which should receive more than passing attention by correspondence or otherwise from this department.

With reference to class room equipment which was mentioned in last year's annual report no additions have been made. In this respect the department work is seriously hampered as the present equipment of class room is not sufficient to demonstrate even the more common conditions and structures to say nothing of those of interest to students electing this work in the junior and senior year. It is hoped that this feature may be ensured to the students during the ensuing year.

Respectfully submitted,
L. M. HURT,
Professor of Veterinary Science.

East Lansing, June 30, 1909.

REPORT OF THE MILITARY DEPARTMENT.

President J. L. Snyder:

Sir—I have the honor to submit my report of the Military Department for the year ending June 22nd, 1909.

During the first half of the fall term the new cadets were instructed in the school of the soldier, being divided into squads of eight, and instructed by sophomore cadet corporals, the instruction being superintended by the senior cadet officers. The remainder of the old cadets were instructed in company drill, close order by the junior cadet officers.

The last half of the fall term the new cadets were drilled in the armory under their cadet officers in the school of the squad and company. The sophomores were given a course of ten lectures in Field Service Regulations, embracing particularly the subjects of Organization, Advance, Rear, and Flank Guards, Outposts, Marches, Patrols, and Camp Sanitation.

At the beginning of the winter term, on account of the increase of cadets in the corps, the organization was changed from a battalion of six companies to a regiment of two battalions of four companies each. During the winter term the new cadets continued their work in the armory under senior cadet officers and junior non-commissioned officers. The new cadets of each battalion also attended nine lectures in the school of the soldier and squad delivered by their cadet majors. The sophomores received a course of ten lectures in U. S. Infantry Drill Regulations, particular attention being paid to battle exercises. They also received courses of lectures in Small Arms Firing Regulations and Guard Duty, and practical instruction in rifle firing. The cadet officers were also instructed in their particular duties, the commandant devoting 20 hours to this work.

During the spring term all drills have been held out of doors, the first drill being held April 12th. The first drills were devoted to battalion work particularly, each company having participated in battalion parades and battalion drills, besides company drills in extended order and target practice. The sophomore class also received instruction in guard duty. After this regimental work was taken up. The corps of cadets was inspected May 20th by Capt. M. J. Lenihan, Gen. Staff, U. S. A., and made a most creditable showing.

The military exercises ordered by the inspector were as follows: regimental review and inspection, regimental drill, battalion drill by each battalion, company drill, the last being in the nature of a competitive drill, the judges being Col. J. N. Cox, Capt. John C. Durst, and Roy Vandercook of the Michigan National Guard.

Company F. Capt. W. N. Moss, was given first place, Company B, Capt. T. M. Hooper, second, and Company E, Capt. E. G. Hulse, third. A regimental parade was then ordered. The regiment was formed as an advance guard to a brigade. It was assumed that the advance guard was attacked by a considerable force and made to deploy to hold the line. Each cadet was supplied with 10 rounds of blank cartridges. The Hospital Corps established a dressing station and applied the first aid pocket for supposed gun shot wounds and fractures.

The enrollment of the corps at the date of inspection was 607 cadets actually drilling. Of this number seven were absent sick, and three absent without leave, 597 being actually in ranks in uniform.

During the spring term the corps of cadets has been reviewed and inspected by Adj. Gen. W. T. McGurrin, Qr. Mr. Gen. J. N. Kidd, Col. J. N. Cox, Col. W. Rogers, National Guard of the State.

On Decoration Day the entire corps proceeded to Detroit, taking part in the street parade. The corps formed at 10:30 a. m. and marched to the Pere Marquette spur track at the college. Each organization was consigned a coach, and the entraining was done promptly and orderly. The train reached Detroit at 1:20 p. m., and the regiment detrained promptly, and proceeded to its position, arriving there at 2:00 p. m. The column moved at 2:15 p. m., the corps of cadets formed the second division and marched in column of platoons.

After the street parade, the corps proceeded to Campus Martius, where a regimental parade and review was held. The regiment passed in review before General H. M. Duffield, U. S. A., Gen. C. A. Coolidge, U. S. A., and a number of other military men of the City of Detroit. At 4:00 p. m. the cadets were dismissed. The regiment formed at 11:00 p. m. at the Light Infantry Armory and marched to the depot, where it entrained promptly and orderly. The train did not reach the college until 4:00 a. m., though it left Detroit at 11:30 p. m.

The splendid showing made by the cadets both in ranks and out of ranks was most gratifying to the commandant, and reflected credit on the college.

The band, under the direction of Mr. A. J. Clark, is a splendid musical organization, and has done much to stimulate the military work.

During the year the cadets have organized a rifle club, under the auspices of the National Rifle Association. They participated most creditably in the Intercollegiate Rifle Match, held March 26th, 1909.

The seniors have taken great interest in the military work, twenty-five drilling against fifteen last year. Any of these cadets who desire are eligible to appear for examination July 12th, 1909 with a view of being appointed second lieutenant in the regular army.

Before closing my report, I desire to express my appreciation of the good work done by the following senior officers:

C. C. Taylor, C. J. Oviatt, W. D. Frazer, G. B. Kamps, W. C. Trout, R. W. Taylor, C. W. Lapworth, D. L. Boyd, B. L. Clark, T. M. Hooper, H. C. Pratt, W. N. Moss, C. Greenhoe, J. N. Bidwell, J. O. Linton, B. H. Roberts, O. W. Fairbanks, J. A. Mitchell, F. C. Taylor, and M. L. Tower.

Very respectfully,
F. W. FUGER,
Capt. 13th Inf., Commandant.

East Lansing, Mich., June 30, 1909.

REPORT OF THE LIBRARIAN.

To the President:

Sir—The following is the report of the library for the year ending June 30th, 1909. Ten hundred six bound volumes have been added to the library during the year, of which four hundred fifteen were purchased, one hundred thirty-eight were gifts, and four hundred fifty-three came by binding.

Four hundred twenty-nine pamphlets and unbound volumes have been presented to the library, and acknowledgment made in all cases where the donor was known. We therefore omit to make individual mention at this time.

For bound volumes we are indebted as follows:

American Shorthorn Breeders' Ass'n, 7.
Bradley's Miscellaneous Writings.
Burrows, Hon. J. C., 1.
Butterfield, Pres., K. L., 1.
Continental Dorset Club, 2.
Cambria Steel Co., 1.
Canadian reports, 13.
Chilean Nitrate Works, 1.
Collinge, W. E., 2.
Davey, The Tree Doctor.
Holstein-Friesian Ass'n, 3.
Iowa, State Board of Agriculture, 1.
Iowa Academy of Science, 1.
Illinois Farmers' Institutes, 1.
Kansas Board of Agriculture, 1.
Library of Congress, 1.
Louisiana Board of Agriculture, 1.
Maine Board of Agriculture, 1.
Maine State Forest Commissioner, 1.
MacDonald, J. R., Geography of New Zealand.
Manning, W. H. Surveying and Arranging Home Grounds.
Mass. Labor Bureau, 1.
Mass. Board of Health, 1.
Michigan reports,
  State Board of Agriculture, 1.
  State Board of Health, 1.
  Farmers' Institutes, 1.
  Supt. of Public Instruction, 1.
  Senate Journal, 1.
  House Journal, 1.
  Vital statistics, 2.
Michigan Academy of Science, 1.
Michigan Pioneer Society, 5.
Missouri Botanic Gardens, 1.
National Conference of Charities and Corrections, 1.
New Jersey Board of Agriculture, 1.
New Jersey Board of Health, 2.
New York State Library, 17.
Northwestern Expanded Metal Co., 2.
Oklahoma Board of Agriculture, 1.
Prang Educational Co., 1.
Present to young men, 2 vols.
Pettit Prof. R. H., 1.
St. Louis Park Commissioners, 3.
United States reports,
  Dept. of Agriculture, 8.
  Bureau of Education, 3.
  Bureau of Commerce and Labor, 3.
  Army, 1.
  Census Bureau, 4.
  Interstate Commerce Commission, 10.
  Navy Dept. 2.
  Treasury Dept. 3.
Ware, L. S. Cattle Feeding with Sugar Beets, etc.
Wilson, Prof. V. T., 2.
Wisconsin Board of Agriculture, 1.

In the reading room may be found four hundred fifty-seven periodicals, foreign and American, of which three hundred twenty-nine are purchased by the college, and one hundred twenty-eight are received either in exchange, or as gifts from publishers. The publications thus received are as follows:

Adrian Times.
Agricultural Gazette of N. S.
Agricultural Advertising.
Agricultural Student's Gazette, England.
Allegan Gazette.
American Agriculturist.
American Cheesemaker.
American Economist.
American Missionary.
American Poultry Advocate.
American Sheepbreeder.
American Sugar Industry.
American Swineherd.
American Thresherman.
Arboriculture.
Armada Graphic.
Arrow, The.
Australiasian.
Bay City Times.
Battle Creek Journal.
Bear Lake Beacon.
Belding Banner.
The Berkshire World & Corn Belt Stockman.
Better Fruit.
Bulletin of the College of Agriculture, Tokyo.
Canadian Horticulturist.
Cattle Specialist.
Chicago Daily Farmers' & Drovers' Journal.
Chicago Packer.
Christian Herald.
Columbia University Quarterly.
Congressional Record.
Daily Drovers' Journal & Stockman, Omaha.
Dakota Farmer.
Economic Bulletin.
Farm and Fireside.
Farm and Home.
Farm Life.
Farm News.
Farm World.
Farmers' Advocate.
Farmers' Guide.
Farmers' Tribune.
Farmers' Voice.
Florists' Exchange.
Fruit Grower.
Garden.
Garden Magazine.
Gleaner.
Gleanings in Bee Culture.
Good Health.
Grand Ledge Independent.
Hawaiian Forester.
Hillsdale Leader.
Hillsdale Standard.
Hoard's Dairyman.
Holstein-Friesian Register.
Holstein Friesian World.
Home and Farm.
Homestead.
Horseshoers' Journal.
Horse World.
House and Garden.
Improvement Era.
India, Dept. of Agriculture Report.
India, Dept. of Agri. Memoirs (Botanical Series) Agri. Research Inst., Pusa.
India, Dept. of Agri. Memoirs, (Chemical Series) Agri. Research Inst., Pusa.
India, Dept. of Agri. Memoirs (Entomological Series) Research Inst., Pusa.
India, Dept. of Agri., Agri. Journal of India Series, Research Inst., Pusa.
Indian Craftsman.
Indian's Friend.
Indiana Farmer.
Iowa Horticulture.
Jamaica Dept. of Agriculture.
Jersey Bulletin.
Journal of Agri., Australia.
Journal of Agri., Vistoria.
Journal of Agri., West Australia.
Kalamazoo Telegraph.
Kansas Farmer.
Kimball's Dairy Farmer.
Lansing Journal.
Lawton Leader.
Lewiston Journal.
Jener Institute of Preventive Medicine, Trans.
Live Stock Journal.
Live Stock Report.
Mark Lane Express.
Michigan Dairy Farmer.
Michigan Farmer.
Michigan Mirror.
Michigan Presbyterian.
Midland Farmer.
Milchwirtschaftliches Centralblatt.
Missouri Valley Vet'y. Bulletin.
Moderator Topics.
Morenci Observer.
National Stockman & Farmer.
New York Meteorology (Draper's Hourly Readings).
N. Y. Produce Review.
Official Gazette, U. S. Patent Office.
Orange Judd Farmer.
Oregon Agriculturist.
Owosso Press American.
Park & Cemetery.
Petoskey Independent Democrat.
Philippine Agri. Review.
Practical Farmer.
Publicity Magazine.
Reliable Poultry Journal.

Republic.
Rockefeller Institute for Medical Research, Studies.
Rural Advocate.
Rural New Yorker.
Saginaw Evening News.
State Republican.
Southern Cultivator.
Special Crops.
Successful Farming.
Tuscola County Advertiser.
Wallace Farmer.
Washington Academy of Sciences, Proceedings.
Weather Review.
Western Journal of Education.
Williamston Enterprise.
Wilson Bulletin.
Writer.
Ypsilantian.

The M. A. C. Record exchanges are also placed in the reading room, and the catalogues of leading educational institutions of the country are received and filed in the librarian's office.

The publications of the various agricultural experiment stations of the country, and the publications of the U. S. Dept. of Agriculture, are also received and filed, together with the card indexes sent out by the U. S. Dept. of Agriculture, and which cover the publications of all state experiment stations, and the publications of the Dept. of Agriculture.

The library hours remain practically unchanged. During the extra hours of opening the library has been in charge of Mr. C. H. Spurway, a senior, to whom our thanks are extended for efficient service. Our regular assistant, Miss Agnes Crumb, has been faithful and painstaking in the discharge of her duties, and we are glad to retain her for another year.

The number of books drawn from the library during the year was five thousand five hundred thirteen. No record can be kept of books used in the library.

Fines to the amount of $35.86 have been collected.

Through the courtesy of the dean of engineering, Prof. G. W. Bissell, we have been allowed to continue to use a room in Engineering Hall for storage. This room, however, will not be available after Sept. 1st, as it will be needed for class purposes. We hope to secure a place in the new Agricultural building which we may keep until such time as a much needed library building is erected.

To the library of the Experiment Station sixty-four books have been added. Fifty by gift, thirteen by purchase, and one by binding.

The college library now numbers 27,798 volumes. The Station library contains 2,730 volumes. Total in both libraries 30,528 volumes. Included in this total are all books in department libraries, so far as they have been catalogued.

Respectfully submitted,
LINDA E. LANDON,
Librarian.

East Lansing, Mich., June 30, 1909.

REPORT OF THE DEPARTMENT OF PHYSICAL CULTURE AND ATHLETICS.

To the President:

I have the honor of submitting the following report of the work of the Department of Physical Culture and Athletics for the year ending June 30th, 1909:

As in the past, the work has divided itself naturally into the two general lines; the developing and maintaining of representative college teams in all branches of athletics, and that work given to reach as far as possible, the entire body of young men and to assist in building up for them strong, healthy bodies and manliness.

The several athletic teams representing the college have had a successful year. The football team did not suffer a defeat during the season. Of the games which this team played the one most worthy of mention, was the nothing to nothing game with the University of Michigan on the local field before the largest crowd ever at an athletic event at the college. The basketball team again won the state college championship. The relay team was the best the college has ever produced and represented the college at Philadelphia in the annual games of the University of Pennsylvania. The track team had a good year and again competed in the Western Championships upon the invitation of the Western Conference Colleges. At this meet the western two mile championship, which was won in 1908, was again won. The baseball team won eleven out of the fourteen games played; while the tennis team won all its matches except the one with the University of Michigan, which was a draw.

The department has made a special effort this past year to reach and interest as many of the young men as possible. The usual class work in indian clubs, dumb bells, bar bells, free arm and breathing exercises, apparatus work and games was offered as heretofore, while inter-class, inter-hall and inter-society competition was carried out in all branches of sport, thus inducing a larger number to take some sort of exercise, as well as offering wholesome recreation and an outlet for the surplus animal spirits of the young men. In this effort, I believe the department has been more successful than in past years. A larger percentage of young men has elected to do work of some kind and it seems as if the interest and support has been better than in the past.

I wish again to call your attention to the necessity of a gymnasium building. The armory is not only not at all adapted for work in physical training, but, used as it is for all purposes, has become so overcrowed that at times this year, the work became disorganized and some had to be entirely abondoned. This lack of time and space effects, principally, the regular class work in physical training, planned especially for those who do not take part in athletics of any kind and which really is the vital work of the department. This branch of the work is so essential to the life of the institution and to the health of our students that we can not afford to overlook it.

The department again, early in the spring, held an inter-high-school field and track meet to which were invited all of the state high schools, The meet was very successful, about forty schools from all parts of the state sending representatives.

The bath house, which the department has charge of, continues to be of great benefit to the institution. Eighty-five per cent of the young men elected to pay the fee this year, thus availing themselves of the privileges of this building.

Respectfully submitted,
C. L. BREWER,
Professor of Physical Culture and Director of Athletics.
East Lansing, Mich., June 30th 1909.

REPORT OF THE DEPARTMENT OF AGRICULTURAL EDUCATION.

President J. L. Snyder,
East Lansing, Mich.

Dear Sir —I herewith submit a report of my labors for the year.

1. During the winter and spring terms I have taught the classes in education, that is, science of education and history of education.

2. I visited twenty high schools with a view to introducing courses in agriculture.

3. I gave addresses in ten farmers' institutes.

4. I have visited and addressed twenty-five granges and farmers' clubs in the interest of agricultural education.

5. I have lectured in four teachers' institutes.

6. I have prepared a course of study in agriculture for high schools and a report showing the work done in the one experimental high school during the year. These have been published in pamphlet form.

7. I arranged a course of reading for farmers and farmers' wives. This work is termed the college extension reading course. The books selected for men were Plumb's Types and Breeds of Farm Animals and Vivian's Principles of Soil Fertility. The books for women were Parloa's Home Economics and Rowe's Physical Nature of the Child. The outline of the course was published in pamphlet form and distributed to all the granges and farmers' clubs of the state, also a large quantity of the bulletins were sent into Jackson county, Mason county, Saginaw county, Shiawassee county and Van Buren county to be distributed by the commissioner of schools in the school districts.

RESULTS.

1. We have had one high school giving the full course in agriculture. This school is located at North Adams, Mich., and the teacher is Mr. Roswell G. Carr. Forty young men of the high school were engaged in this work. The results are tabulated in bulletin No. 2 issued in March 1909.

2. I have organized four high schools for the teaching of agriculture during the years 1909 and 1910. These are located at St. Louis, Otsego, Hillsdale and Hudson. The men employed to teach agriculture are A. J. Hutchins, R. G. Hoopingarner, C. W. Mason and B. H. Roberts.

3. I have organized reading clubs in fourteen granges, one Arbor of Gleaners and four farmers' clubs. The total number of readers during the year has been 193 and so far as I can learn all are pleased and satisfied with the work.

4. Upon careful investigation I find that a course in agriculture is given in the normal schools at Mt. Pleasant and Kalamazoo, also a short course is given in each of the forty-one county normal training classes. I find also that some nature study and a few of the elements of agriculture have been presented in about 600 rural schools of the state.

In regard to the summer work at the college will say that 20 students were enrolled during the summer of 1908. At this date 26 students are enrolled for the summer courses of 1909. This does not include the forestry students. Among those enrolled are superintendents of schools, one high school principal, six rural school teachers, five graduates of this college and the balance are teachers of county normal training classes.

This is in brief an outline of the work in agricultural education for the past year.

Respectfully submitted,
WALTER H. FRENCH,
Professor of Agricultural Education.

East Lansing, Mich., June 30, 1909.

MICHIGAN FARMERS' INSTITUTES. SUPERINTENDENT'S REPORT.

To President J. L. Snyder:

Sir—The institute season just closed has, in every respect, been one of more than usual success. Not only has the number of meetings been considerably larger than in any previous year but the attendance and interest were never surpassed. During the institute season regular meetings were held in every county in the Lower Peninsula, except in Bay county, and two stops of the institute train were made there. The number of institutes in the Upper Peninsula was also fully as large as in previous years.

Previous to the opening of the regular institute work, the lecturers were consulted regarding the holding of a Normal Institute at the college and, without exception, they expressed themselves as favorable to the idea and agreed to attend a three-day normal institute at their own expense. The meeting was held during the third week in November and all but three of the lecturers were in attendance and they had made their plans to be here but were unavoidably kept at home. This was the fourth in a series of normal institutes and from their very inception they have been very helpful to the lecturers. The program has been largely devoted to addresses by members of the college faculty regarding the discoveries and developments in agricultural science along their respective lines. As the lecturers during the summer months have been engaged in their farm and home duties, it would hardly be expected that they would keep fully up-to-date, and the opportunity afforded by the Normal Institute to "brush up" along their respective lines was not only eagerly welcomed by them but the benefits from the meeting were very noticeable in their work throughout the institute season.

The regular institutes held under the auspices of the county institute societies were for the most part held between November 10th and March 1st, closing with the Round-up Institute at Mt. Pleasant. With few exceptions, the county institutes lasted two days with five sessions, but in some instances, a three-day institute was arranged at which the last three sessions were joint meetings with the county teachers' institute. At nearly all of the county institutes the attendance was unusually large and, at several places, it would have been considerably increased had the capacity of the largest hall not been overtaxed. From several counties the report came to me that fully as many failed to get inside of the building as were actually accommodated.

The largest total attendance, aside from the Round-up Institute, was at the Ionia county institute at Ionia where the number present at the eight sessions was slightly over 4,800, or 600 for each session, but the Lenawee county institute showed an attendance of 3,843 at five sessions, or an average of 769 per session. Aside from the Adrian institute, the largest attendance per session was at St. Louis where the average for the six sessions was 703 with a total of 4,217, or nearly 400 more than were present at Adrian. At these meetings in particular the secretary and local managers had taken unusual pains to have the institutes thoroughly advertised and acknowledgment is hereby made to the local papers which made the above results possible. The county papers throughout Michigan are evidently taking increased interest in institute work and the general improvement in the attendance noted has in a majority of cases been due to the notices of the meetings which have been freely given.

The general increase in the interest taken by the farmers of the state in institute work led to there being far more calls for one-day institutes than it was possible to supply, but by carefully arranging the meetings so as to economize in the time and travel of the speakers, the number of institutes was considerably increased at a slight addition to the expense in previous years. The cost of holding the institutes has also been materially decreased by the entertainment and transportation furnished the speakers by the officers and members of the county institute societies. In this way it has been possible to hold five or six institutes in a county where there could have been but three or four had it been necessary to pay hotel and livery bills for the lecturers.

Although there has been a large increase in the number of institutes and in the total attendance at the one-day institutes, the increase in the attendance per session has not been in proportion. Many of the meetings were held in school houses or grange halls in sparsely settled communities and in this way it was possible to reach many farmers who had not been in the habit of attending institutes.

As has been the case for a number of years, considerable attention was given at all of the institutes to the improvement and care of corn and at several of the institutes what might be termed corn schools were held.

Samples of corn were distributed and those in attendance were given practical exercises in corn judging.

For the one-day institutes but a single state speaker was furnished, the remainder of the time being assigned to the local part of the program. At the county institutes there were always two state lecturers present at each session and in most cases there was a third speaker for the afternoon and evening sessions upon topics relating to good roads, forestry, education, or the home. In fully two-thirds of the counties a separate section for women was asked for upon at least one afternoon. At several points the women's section occupied an entire day or perhaps two afternoons. There were also a number of counties in which, although no distinct section was held, one of the evening sessions was in charge of the ladies and the program was carried out by them. Nearly every county in which separate women's sections have been held in the past has asked to have them continued.

The holding of women's sections has in many places furnished an overflow meeting and has thus made it possible to accommodate the large number which wish to attend. By having them in the afternoon when the topics at the general session are not of especial interest to the women, it enables the latter to get more out of the meeting.

At the conferences held in connection with the Round-up Institute it seemed to be the general impression that it was desirable to have a woman speaker present at each county institute for the entire two days instead of for one or two sessions as has been the case in the past. It was also thought if there could be one man to speak upon general farming topics and one woman speaker who could conduct the women's section and, in addition to addresses relating to the home, could give one or two talks that would be of interest to the men as well as to the women from the farm, it would be possible to fill in the remainder of the time with local speakers except that in some places lecturers upon education and good roads were asked for. This would reduce the expense of holding the county institute and make it possible to hold at least one more one-day institute than is now held.

FARMERS' INSTITUTE SPECIAL.

The success of the special institute train in the three previous years made it an easy matter to secure a similar favor from the railroads in 1909, and, upon request, the Pere Marquette, Detroit and Mackinac, and Michigan Central roads agreed to run a special train over their lines. The train left Lansing over the Pere Marquette road on Monday morning, March 29th and spent the week upon that road in the eastern part of the state. The same territory was covered in 1907 but, as the trip lasted only four days as compared with six in 1909, only about one-half of the places where stops were made in the latter year were reached in 1907. Leaving Bay City, Tuesday, April 6th, the train was run over the Detroit and Mackinac road to Cheboygan and three days were spent returning from there to Lansing over the Michigan Central. Except for the stops made on the final run from Saginaw to Lansing, none of the points had been previously visited.

During the eleven days sixty-five stops of sixty to ninety minutes each were made. The train consisted of three baggage cars and two or three passenger coaches in addition to the locomotive. One car was given up entirely to an exhibit of poultry, including representatives of a dozen breeds of chickens and ducks, bone grinders, feed boxes, dusting machines and samples of rations. Another car was used for demonstration of spraying and milk testing. It contained spray pumps, prepared spraying mixtures, samples of dangerous insects and diseases, and large photographs showing various horticultural operations. Much interest was taken in the demonstration of milk testing and at many points a large number of samples of milk were brought to the train for examination. The exhibit also included model sanitary stalls, prepared grain rations for animals, and photographs of typical animals of the various classes of live stock. The third car contained the farm crop exhibits. The walls were covered with samples of the different forage crops and with numerous varieties of the small grains. Upon a table running the entire length of the car were shown typical ears of many kinds of corn. Several forms of corn racks and methods of testing corn and other farm seeds were displayed. This exhibit showed very conclusively the importance of giving attention to the careful selection of seed and of testing it carefully before planting. At one end of the car was an exhibit of road-making materials and of photographs showing many of the roads built under the state reward road act in charge of Frank F. Rogers, deputy highway commissioner.

The runs between stations generally occupied from ten to fifteen minutes and on the arrival of the train the crowds in attendance often overtaxed the capacity of the passenger coaches so that it was necessary to use the baggage cars in order to accommodate them.

At most points from forty to sixty minutes were used for from four to six talks upon topics that were thought to be of special interest to the farmers gathered and the remainder of the time was spent in the baggage cars explaining the exhibits. Among the speakers were, Mr. W. F. Raven, upon "Corn Growing;" Mr. L. W. Oviatt, who spoke upon "Beet Culture," "Sheep Feeding," and other topics; Prof. A. C. Anderson, who during the first week discussed the "Breeds of Dairy Cows;" Mr. W. B. Liverance who demonstrated milk testing and during the second week took Mr. Anderson's topic, "Breeds of Dairy Cows;" Prof. H. J. Eustace and Prof. C. P. Halligan, each of whom spent three days upon the train speaking upon topics relating to spraying for insects and diseases; Prof. J. G. Halpin, who was with the train for the entire trip, discussed "Breeding and Feeding Poultry;" Mr. C. H. Spurway, who discussed methods of curing and testing farm seeds; Frank F. Rogers, deputy state highway commissioner, who gave short talks regarding methods of handling country roads and explained the requirements under the state reward and county road laws. The writer was in charge of the train throughout the trip and at many points spoke upon the treatment of insects and diseases injurious to farm crops.

During the entire trip representatives of the railroads accompanied the train and extended many favors. All of them expressed themselves as well pleased with the results of the trip and were anxious to continue the service another year.

THE ROUND-UP INSTITUTE.

Following the previous custom of having the Round-up Institute at the close of the season at some point away from the college in alternate years, the invitation extended by the Isabella County Farmers' Institute Society to hold the Round-up Institute for 1909 at Mt. Pleasant was accepted, and arrangements were made for holding a meeting at that place. The local officers interested the Business Men's Association and were able to secure the use of the opera house, the free use of which was donated by the Isabella County State Bank, and the Central Normal School and the United States Indian School through President C. T. Grawn and Superintendent Cochran, invited the institute to hold at least one session in their respective auditoriums. The attendance throughout the entire session of the institute was very large, and although the two leading hotels had promised reduced rates and had agreed to accommodate a considerable number of guests, after the arrangements had been made refused to grant special rates or to make provision for accommodating the speakers and delegates, through the efforts of Mayor Walter Snider and the Business Men's Association, all of the delegates and visitors were assigned to private houses, the best residences of Mt. Pleasant being thrown open for the purpose.

The institute lasted four full days and was continued a fifth day as a teachers' institute. A women's congress was held on Wednesday and Thursday afternoons and on Friday afternoon there was a joint teachers' and patrons' meeting in the Methodist church in addition to the general session at the Opera House. The total attendance for the twelve sessions was 10,125.

The corn exhibit under the auspices of the State Corn Improvement Association proved of great interest and value and brought out a large number of exhibits. A complete list of the awards is given in the body of the report. Through an arrangement with the State Agricultural Society cash prizes from a fund donated by the latter were paid with the understanding that the corn should be scored and was to become the property of the society, to be exhibited at the State Fair to be held in Detroit in September, 1909.

A large exhibit of small grains and vegetables was also collected by a committee of the Isabella County Farmers' Institute Society for which liberal prizes donated by the farmers and merchants of Mt. Pleasant were offered.

Corn exhibits have been made special features of many of the county institutes held during the year. They have not only served to foster and increase interest in better methods of selecting and growing corn and the exhibits as compared with those made in previous years show a very striking advance in both respects. In several counties prizes were offered for corn grown by boys and girls under eighteen years of age. They not only brought out a lively competition but served to interest young people in farmers' institutes and, best of all, in rural affairs in general. This work will be continued during the present year and, in a number of counties, more than 100 boys are preparing to take part in the contest. It is proposed to broaden the work to include potatoes and other staple crops for the boys, and prizes will be offered for the best samples of bread, butter and sewing by the girls.

CONFERENCES OF DELEGATES.

The plan of having meetings of institute lecturers and delegates from the county institute societies at the time of the Round-up Institute was continued this year. The number of counties represented, especially from the northern part of the state, was unusually large and the conferences which were especially devoted to methods of improving the farmers' institute work in Michigan during the coming year were considered very helpful and excellent results are confidently expected from them.

ACKNOWLEDGMENTS.

Although members of the faculty of the Agricultural College are particularly busy with their classes of regular and short course students during the period when most of the institutes are held, a considerable number have spent one to three weeks in attendance upon farmers' institutes and their services have been very helpful and in most cases their attendance at future institutes was requested. The faculty of the Western Normal School and the State Highway Commissioner have also taken a leading and active part in many of the institutes. The regular state lecturers, many of whom have engaged in the work with a personal and pecuniary sacrifice, have rendered loyal, conscientious and efficient service. The reports of their work received from the local officers have, with very few exceptions, been unusually favorable and indicate the increased ability on the part of the lecturers to instruct and interest their audiences.

The officers of the county institute societies, and the secretaries, in particular, have worked hard to make the institutes successful. In many of the counties this has been done without any remuneration, whatever, even for expenses incurred while attending the institutes, but in a few instances the funds raised from membership fees and other sources have been sufficient not only to pay the expenses actually necessary, but a small allowance ranging from ten to thirty dollars has been made to the secretary for his services in addition to paying his expenses as a delegate to the Round-up Institute. This has not only made it possible to induce better men to enlist in the work but they have felt that they could give more attention to the duties and this has added to the success of the meetings.

The state lecturers have been men and women from Michigan farms with one exception. For two years it has been possible to secure the services of J. P. Davis, of Sheridan, Indiana, as one of the lecturers and this year so many calls were received for his services and the work he had rendered was so satisfactory that he was engaged for the entire month of February, including the Round-up Institute, at which he was present for three days and, besides giving three addresses upon topics relating to corn culture, he acted as judge of the corn exhibit.

SUMMARY OF THE WORK OF THE YEAR.

Institutes have been held in 75 counties, including a three-day institute at Traverse City and the Round-up Institute lasting four days at Mt. Pleasant. There were altogether 348 sessions of the county institutes with a total attendance of 72,473. In addition to this, 329 one-day institutes were held with 815 sessions and an attendance of 85,090. The institute train made a run of eleven days with 65 stops at which there was a total attendance of 7,485, or a combined attendance at all of the institutes, not including the Normal Institute at the College, of 500.

The annual appropriation for institute work was $8,500, the same as for several years past. From this all expenses have been paid, including the per diem and traveling expenses of the lecturers, the salary of the superintendent and clerk, and all expenses of the office. The cost of printing 10,000 copies of the annual institute report, of which 500 were bound in cloth, a volume of more than 300 pages, and of mailing them to the members of the county institute societies has also been defrayed from the regular institute fund. Although the local expenses are met by the membership fees in the county institute societies, some 10,000 posters were printed and mailed to the local managers to assist in advertising the meetings. The Round-up Institute also required a large expenditure as an allowance was made towards the expenses of the delegates from the county institute societies and, although there was no allowance for per diem, the railroad and hotel bills of the lecturers and others upon the program were paid from the institute appropriation.

Respectfully submitted,
L. R. TAFT,
Superintendent of Michigan Farmers' Institutes.

East Lansing, Michigan, June 30, 1909.

REPORT OF STATE INSPECTOR OF ORCHARDS AND NURSERIES.

To the State Board of Agriculture:

Gentlemen—The following report of my work as State Inspector of Orchards and Nurseries is herewith submitted.

The inspection of the nurseries was taken up soon after the opening of the year, and they were found in unusually good condition. The few nurseries in which San Jose scale was found at the last inspection received even more than the usual attention. Most of them received a preliminary inspection early in August, and where there was any indication that any of the scale had escaped, the spraying of the trees in August was required. As a rule, the nurseries were found in good condition, and care had been taken to not only destroy all of the scale in the nurseries but, as precautionary measures, fruit and other trees in the vicinity likely to be attacked had either been sprayed or destroyed.

During the months of September and October all of the nurseries were given their final inspection for the year, the idea being to make the inspection just before the trees were to be dug, thus lessening the possibility of reinfection.

When any trees were found to be infested they were broken down and the owners were required to destroy them at once. All of the other stock in the vicinity, if of species subject to the attack of the San Jose scale, was ordered fumigated with hydrocyanic acid gas.

This treatment if properly given is entirely effectual, and besides being cheap and rapidly performed, has the additional merit of being safe to use on the trees. The principal drawback to its use is that the gas diffuses rather slowly, and when the work is done in a large room we have made the requirement that no trees be more than ten feet from the fumigating pan, and in order that an even distribution of the gas be secured, have required that the trees be exposed to the gas for one hour, instead of thirty minutes as formerly. Careful experiments have shown that when the trees are fairly well ripened there is no danger, whatever, when trees are fumigated for this length of time, using one ounce of cyanide of potassium for 100 cubic feet of space. In fact, this is the strength used in California for fumigating growing orange trees.

During the spring months many of the larger nurseries were visited to make sure that the stock carried over and the surroundings were in a satisfactory condition. Careful watch was also kept of the stock as it was packed for shipment, and frequent examinations were made of the trees purchased by them, and especially of those brought in from other states.

INVASION OF BROWN-TAIL MOTHS.

Early in January the New York Department of Agriculture reported that its inspectors had found winter nests of the brown-tail moth containing living larvae upon nursery seedlings imported from Angers, and other points in France.

This insect has periodically caused immense losses in Germany and other European countries and has been in Massachusetts for some twelve or fifteen years and in that time has spread throughout New England, it having been found at the extreme northeast corner of Maine.

While it is most commonly found on fruit trees, being particularly fond of the foliage of the pear, it also attacks many of the forest trees, so that the injury it might cause, if it should secure a foot-hold in Michigan, would be wide-spread.

Though its ravages can be checked in various ways, it would be at a considerable expense, and especially for the forests it would be prohibitive. Every precaution should therefore be taken to prevent, or at least to delay the introduction of this pest into Michigan orchards as long as possible. And in order that its spread may be checked, if it once obtains a foot-hold, every one should be informed regarding its appearance, life history, and methods of combating it.

DESCRIPTION OF BROWN-TAIL MOTH.

The moth itself is pure white in color, except for a thick tuft of yellowish brown hairs at the tip of the abdomen. It has a wing-spread of 2¼ inches and is a strong flyer. The moths appear in July and deposit eggs upon the underside of the leaves, in rather long, slender clusters of a golden-brown color.

The eggs hatch in August and the caterpillars, which reach a length of two inches, are bright orange in color with a broken row of white spots on either side of the back. The caterpillars also have two bright red spots on the back towards the rear end. While quite small they draw the leaves together and spin a silky web about them, making a sort of tent in which they pass the winter. The nests are from two to four inches in length and are firmly attached to the branches by means of silken threads. At that time, the caterpillars are not more than one-fourth inch in length.

As soon as spring comes, they emerge and begin feeding on the buds and afterwards upon the leaves. In case the number of nests upon a tree is large, they will soon be stripped of their foliage, as each nest contains the larvae from one egg cluster which numbers from 200 to 300, or more.

One of the objectionable features of this insect, especially if in villages and cities, is that the caterpillars have long, coarse hairs, the tips of which are barbed. If one touches the caterpillars or even the "nests" or cocoons, the hairs will penetrate the skin and produce a sort of rash, supposedly from some poisonous principle which they exude and which acts on the red corpuscles of the blood. The irritation produced is quite painful and annoying.

REMEDIES FOR BROWN-TAIL MOTH.

At the present time the greatest danger of the introduction of this insect is upon nursery stock. They will be quite small during the winter, but the nests are very easily detected as they are attached to the smaller branches, and at first sight quite closely resemble the cocoon of a large moth.

As soon as report was received of the threatened invasion, the nurseries importing stocks from Europe were at once notified and arrangements were made for inspecting every shipment.

Nearly two million seedlings and other trees were examined and during the early part of the season, nearly every case had more or less nests. They seemed to be most common on the pear and apple, but a few were found upon plum, cherry and rose stocks. Twenty was the maximum number found in any one case of trees, which generally numbered from 8,000 to 12,000, but that this will be enough to do great harm can be seen from the fact that there are about 250 larvae in each nest, or a maximum of 5,000 in a case of trees. Altogether the shipments to nine nurseries were found infested and these received more than nine-tenths of the stock shipped.

A considerable number of consignments from England, Holland, and Belgium were also examined. These consisted for the most part of roses and bay and box trees but no sign of infestation could be detected.

When any infested seedlings were found, they were burned and all others in the case were dipped in kerosene emulsion (1 to 15), or in some of the miscible oils diluted 1 to 20 with water. The packing material was also burned and the packing cases were either burned or thoroughly sprayed, and it is hoped that with this care the introduction of the brown-tail moth has been put off for one year.

In case the insect is found, it will probably be in the larval form and steps should be taken at once to destroy it. During the dormant period the minute larvae will be in the nests and can be readily destroyed, but during the spring and early summer they will be found feeding upon the foliage. It may be possible to brush some of them off and destroy them, but the chief reliance should be upon arsenate of lead, using 5 pounds in 50 gallons of water. This should not only be sprayed over the trees upon which the larvae are found, but upon others in the vicinity that are likely to be infested.

THE DANGER FROM THIS INSECT.

The fruit grower who sprays his trees thoroughly three or four times during the season has nothing to fear from this insect, as it will never be able to get a start, and it will be little more injurious than the common tent-caterpillar. But the farmer and others who do not spray will find it a serious pest as it will soon kill pear and apple trees and in time may spread to the forests where it will be difficult, if not impossible, to control it. Whenever it appears, these winter nests should be destroyed before growth starts and the trees sprayed with arsenate of lead just before they bloom and again as soon as the fruit has set.

THE GIPSY MOTH.

Although this insect has not been found in Michigan, its presence may be looked for at any time, and, when it once becomes established in a locality, it is more to be feared than the brown-tail moth, as it attacks all kinds of trees and cultivated plants.

The moths are very heavy and are not able to fly, hence it depends for its distribution upon the larvae dropping upon carriages, automobiles and railroad trains. There is also a possibility of the eggs being introduced upon nursery stock, or in barrels and other packages in which household goods may be shipped from infested sections.

This insect was introduced into the vicinity of Boston some 25 years ago and has gradually spread until it is now quite generally found everywhere within a radius of twenty miles of Boston.

THE PERFECT INSECT.

The perfect insect is a moth whose wings have a spread of a little more than two inches. They are of a dingy-white color, and marked and streaked with black. It also differs from the gipsy moth by lacking the brown hairs at the tip of the abdomen. As it cannot fly, it seldom gets far away from the pupa case and in fact generally lays its eggs directly upon it, during the month of August.

The egg masses are often nearly two inches long and an inch or more in diameter. They are found on the trunks and branches of trees, or on fences, buildings, or any spot where the larvae happen to be when they are ready to make their cocoons.

Each egg mass contains four or five hundred round eggs about the size of the head of a small pin, which are salmon-colored at first but soon turn dark. The eggs are fastened together by a sort of frothy glue and the mass is covered with tawny hairs rubbed from the abdomen of the female moth.

The insect passes the winter in the egg state and never as a caterpillar, as does the brown-tail moth.

THE GIPSY MOTH LARVAE.

The caterpillars are of a dark gray, or brown color, and the backs are marked with a double row of white spots. There are five pairs of blue spots towards the front end and six pairs of red spots at the rear end of the insect. There are also numerous tufts of rather long, brown hairs. They sometimes reach a length of nearly three inches. The insects reach their full size near the middle of July and transform to pupæ, emerging as moths about the middle of August.

This insect can also be readily controlled by thorough spraying of the infested trees, but other measures are also adopted especially in villages and cities. The work begins during the winter with the destruction of the eggs by soaking them with creosote which has been colored with lamp black. When an attempt is made to collect the eggs, the mass is so brittle that they become scattered. If there is underbrush, it is cut and burned.

As the egg masses are sometimes carefully concealed, it seldom happens that all are destroyed and measures must be taken to combat the larvae when they appear. In case the trees have been cleaned of egg masses, a band of liquid "tangle-foot" three or four inches wide is painted around the trunk. This will remain soft for several days but if it hardens with cold, or from the action of rains, it should be renewed or stirred up using a fine steel comb. The bands should be occasionally examined as if the larvae are very numerous they may crawl upon the "tangle-foot" band and will soon manage to bridge it over. Besides destroying the insects upon the bands, all that are found upon the trunks of the trees above or below the bands should be killed.

Another method of trapping the insects, which is often used in connection with the tangle-foot band, is to place a strip of burlap nine inches wide around the trunks above the tangle-foot. This is tied close to the bark at the center and the upper portion is then bent over. The insects when nearly grown have the habit of crawling down the trunks during the middle of the day, seeking a place to conceal themselves, and can be found in large numbers between the flaps of the burlap where they can be readily destroyed.

While in many cases all of the above methods are used and the trees are later on sprayed with arsenate of lead, the destruction of the eggs combined with one or two thorough sprayings should suffice, and especially as two or three sprayings of fruit trees are necessary against other insects, it would seem that if taken when the insects first appear, it would be possible to control them by that means alone.

The State of Massachusetts has spent several million dollars fighting these insects and, although their ravages have been checked, the insects are continually being found in new territory, so that if the warfare is kept up the expense is not likely to lessen for some years, at least.

An endeavor is being made, in cooperation with the U. S. Division of Entomology to import parasites from Germany, and it is hoped that a marked measure of success will be achieved but as yet the work is in an experimental stage.

SAN JOSE SCALE IN THE ORCHARDS.

Although the San Jose scale was greatly reduced, particularly in the west part of the state by the October freeze of 1906, the numbers are again increasing except where proper attention is paid to spraying. In most sections the people are becoming familiar with the insect and, as they are able to understand the danger to their trees if nothing is done to control it, in most cases they require very little urging to spray their orchards.

Here and there, however, it is but just making its appearance and many fruit growers are not sufficiently informed regarding its appearance so that they are able to recognize it. During the year considerable work has been done in following out reports of the appearance of this disease and although in most instances some other insect has been mistaken for it, we have been able to locate it in many orchards where it had not been hitherto found, and required the owners to spray their trees.

Up to the present time the lime-sulphur solution has given best satisfaction as a remedy against this insect. The original formula of 15 pounds of sulphur and 20 pounds of lime in 50 gallons of water is still very generally used. In some cases it is objected to because it must be used as soon as made. To such persons we recommend the use of only 8 or 10 pounds of lime with 15 pounds of sulphur. This makes a clear solution which can be barreled and kept for a considerable length of time. If very much is required, it can be prepared in a concentrated form by boiling 100 pounds of sulphur and 60 pounds of lime in 50 gallons of water for two hours and diluting when required for use.

Several of the prepared brands of lime sulphur solution on the market, when diluted at the rate of one part to nine or ten of water, contain about the same amount of sulphur in solution as is found in a well prepared home-made mixture. The principal objection to the use of these solutions, as well as that of the clear home-made solution, comes from the fact that they do not show plainly upon the trees and for this reason many persons fail to get as good results as when a surplus of lime is used. Of course it is possible by adding three or four pounds of freshly slaked lime to a barrel of the diluted solutions to whiten the trees the same as when the old formula is used.

THE PEACH YELLOWS.

Although the growers in the peach belt proper have been able to so completely control this disease that they have little fear of it, it is still making serious inroads upon orchards and the scattering trees which are often found upon farms and in gardens just outside the peach belt proper. There, as with the San Jose scale, people fail to recognize it and do not understand its danger, hence it is more difficult to bring about the proper enforcement of the law under the above conditions than in townships where there are thousands of acres of peach orchards.

During the year an endeavor has been made to bring about the appointment of inspectors in townships and cities which do not now have them and in which any of the more dangerous insects and diseases have been found. Considerable time has been spent by myself and deputies with newly appointed township inspectors to make sure that they are familiar with the insects and diseases with which they will have to deal and with the methods of bringing about the enforcement of the law.

DEPUTIES AND THEIR WORK.

No change in the deputies has been made during the year. So far as possible they have been used for the inspection of nurseries and orchards in the vicinity of their homes thus saving in per diem and traveling expenses. Mr. E. W. Allis, of Adrian, has inspected the nurseries in the southeastern part of the state and has given considerable attention to orchard inspection in that region. I was also able to leave in his hands the inspection of the European stocks for the brown-tail moth received by the nurseries at Adrian, Monroe, Detroit, Birmingham and Pontiac. Mr. O. H. Robbins, of Hart, inspected the nurseries and orchards in that part of the state. Mr. H. G. Welch, of Fennville, looked after the inspection in Allegan, Ottawa, Kent, and Kalamazoo counties. Mr. F. A. Wilken, of South Haven, attended to the duties in Van Buren county. Mr. F. C. Stahelin, of St. Joseph, inspected the small fruit nurseries in Berrien county; and Mr. W. C. Eckard, of Eaton Rapids, spent several weeks in the inspection of nurseries in the southwestern part of the state. The other work received my personal attention, except that Mr. L. M. Geismar, inspected the nursery at Negaunee.

For several years an endeavor has been made to secure the more general spraying of the vineyards in the Lawton district for the control of the black-rot. In 1908 the amount of spraying was fully tenfold that of any previous year and although the climatic conditions were quite unfavorable for the development of the disease, a marked benefit from the spraying was noticeable. No only was the injury from rot greatly decreased but the loss from mildew and the grape berry-moth was almost entirely prevented and this alone fully equalled the expense of spraying.

As the grapes in other sections are more or less injured by all of these troubles and comparatively few of the owners are familiar with the insects and diseases or with the means of controlling them, a bulletin was issued in which the life history was discussed and definite directions for spraying were given. An edition of 5,000 was printed and sent out to grape growers over the state.

The fruit growers of Michigan are each year becoming better acquainted with the destructive insects and diseases and are taking increased interest in the subject of controlling them, hence we are finding little difficulty in securing the enforcement of the law when the attention of the owners of infected orchards is called to the matter.

I herewith append a list of Michigan nurseries, of Michigan dealers in nursery stock, and of foreign nurseries licensed to sell nursery stock in Michigan.

List of Licensed Michigan Nurseries, 1908-9.

Alferink, Alfred, Holland, R. 8.
Ann Arbor Nursery Co., Ann Arbor.
Allen Brothers, Paw Paw.
Baldwin, O. A. D., Bridgman.

Balsley, David, Cheboygan.
Blake, William, Niles, R. 6.
Bragg, L. G. & Co., Kalamazoo.
Celery City Nurseries, Kalamazoo.
Central Nursery & Floral Co., Kalamazoo.
Clark, D. H., Holland.
Cole, Levant.
Collins, W. E., Fennville.
Coloma Nursery Co., Coloma.
Coryell, R. J., Birmingham.
Cukerski, Wendel L., So. Wealthy Ave., Grand Rapids.
Culver, O. B., Colon.
Cutler & Downing, Benton Harbor.
Dean, Geo. N., Shelbyville.
Dow, H. C., Kibbie.
Dressel, G. L., Frankfort.
Drought, William, Douglas.
Dunham, E. W., Stevensville.
Dutton, Charles S., Holland.
Essig, W. W. & Co., Jones Bldg., Detroit.
Enders & Dukesherer, Coloma, R. 2.
Ferrand, E. & Son, Vinewood Ave., Detroit.
Fisher, Guyon, Fennville, R. 1.
Flansburg & Potter Co., The, Leslie.
Genesee County Nurseries, Flint.
Grand Rapids Nursery Co., 48 Livingston St., Grand Rapids.
Greening Nursery Company, Monroe.
Gustin, O. F. Adrian.
Haines, J. W., Eaton Rapids.
Hamilton, A. & Son, Bangor.
Hart Nursery, Hart.
Haughey, J. H., Berrien Springs.
Havekost, G. H., Monroe.
Hawley, Geo. A., Hart.
Hawley, H. E., South Haven.
Helmer Farm Nursery, Battle Creek, R. 6.
Hodges, Ezra & Son, Mayville.
Husted, N. P., Lowell.
Ilgenfritz, Chas. A., Monroe.
Ilgenfritz, I. E. Sons Co., Monroe.
Jeffrey, Jas. Sr., Kalamazoo.
Kalamazoo Nurseries, Kalamazoo.
Kellogg, R. M. Co., Three Rivers.
Knight & Son, David, Sawyer.
Lake Shore Nursery Co., St. Joseph.
Lakeview Nursery & Fruit Farm, Baldwin.
Lamson & Rood, Covert.
Maplewood Violet & Nursery Co., Lansing.
Marvin, O. F., Holton.
Maudlin Nursery, The E., Bridgman.
Michigan Nursery Co., Monroe.

Miller, Abner, Fennville.
Munson, W. K. & Son, Grand Rapids.
Muskegon Fruit Growing Co., Muskegon.
Negaunee Nurseries and Greenhouses, Negaunee.
Nelson, J. A. & Son, Paw Paw.
Newell, Reuben, Candler Ave., Highland Park.
Pier, Frank D., Leslie.
Pilkinton, S. H., Portland.
Pontiac Nursery Co., 240 Woodward Ave., Detroit.
Powers, Chas., Douglas.
Prudential Nursery Co., Kalamazoo.
Schild, H. J., Ionia.
Sheldon, W. E., Litchfield.
Singer, W. H., Lapeer.
Smith, E. J., Cheboygan.
Smith, Henry, Grand Rapids.
Sodus Nursery Co., Sodus.
Speyers, Chas M., Willis.
Spielman Brothers, Adrian.
Starr, Geo. E., Royal Oak.
Stephens & Allain, South Haven.
Stoddard, L. H., Kalamazoo.
Stone, John & Son, Hillsdale.
Taplin, Stephen, West Fort St., Detroit.
Tossy, L. F. & Co., 84 Baltimore Ave., Detroit.
Utter, Jay J., Bravo.
Weller, Barend H., Holland.
West Michigan Nurseries, Benton Harbor.
Weston, A. R. & Co., Bridgman.
Whitten, C. E., Bridgman.
Wildemere Gardens, Highland Park.
Wise, Ralph, Plainwell, R. D.
Wolverine Cooperative Nursery Co., The, Paw Paw.
Wooll, I. A., Elsie.

LIST OF MICHIGAN DEALERS IN NURSERY STOCK, 1908-9.

Augustine, L. D., St. Joseph.
Beattie, Thomas, 187 Euclid Ave., Detroit.
Bowser, F. L., Alma.
Clapp, Chester H., 89 Brady St., Detroit.
Davison Nursery Co., Davison.
Freyling & Mendels, 891 Wealthy Ave., Grand Rapids.
Herpolsheimer Company, Grand Rapids.
Heyboer, A., 867 Sutton Ave., Grand Rapids.
Hibbler, Edwin B., 12 Montcalm St. E., Detroit.
Hudson, J. L. Co., Detroit.
Hunter & Hunter, Detroit.
Kimball, D. S., 237 Kirby St. W., Detroit.
Knapp, W. F., Monroe.
Lohrman Seed Company, 73 Gratiot Ave., Detroit.
McCormick Nursery Co., Monroe.

McHugh, J. F., Michigan Ave., Detroit.
Merrill, W. F., South Haven.
Pearson, D. S. & Co.
Smith, P. H., 274 Helen Ave., Detroit.
Souter, Geo. H., Holland.
Strittmatter, Adolph, 1054 Gratiot Ave., Detroit.
Sweet, L. H., Carsonville.
Trankla, Chas. & Co., Grand Rapids.
Webb, D. S. & Co., Fife Lake.
Westgate Nursery Co., The H. L.
Winkworth, R. M., 80 Farrar St., Detroit.

LIST OF FOREIGN NURSERIES LICENSED TO SELL STOCK IN MICHIGAN, 1908-9.

Allen Nursery Co., Rochester, N. Y.
Bogue, Nelson, Batavia, N. Y.
Brown Brothers Co., Rochester, N. Y.
Bryant Brothers, Dansville, N. Y.
Bryant, Arthur & Son, Princeton, Ill.
Cartwright, I. D., 22 St. Clair Bldg., Toledo, O.
Charlton Nursery Co., Rochester, N. Y.
Chase Brothers Co., Rochester, N. Y.
Chase Nurseries, The, Geneva, N. Y.
Cline, J. B. & Son, Rochester, N. Y.
Costich Co., G. A., Rochester, N. Y.
Darling, Irvin C., Son & Co., 1414 E. 88th St., Cleveland, O.
Davis, Franklin Nursery Co., Baltimore and Paca Sts., Baltimore, Md.
Fairview Nurseries, Rochester, N. Y.
First National Nurseries, Rochester, N. Y.
Foster & Griffith, Fredonia, N. Y.
Fremont Nursery, The, Fremont, O.
Harman, M. H. Co., Geneva, N. Y.
Hawks Nursery Co., Rochester, N. Y.
Henby, J. K. & Son, Greenfield, Ind.
Herrick Seed Co., Rochester, N. Y.
Hooker, Wyman & Co., Rochester, N. Y.
Home Nursery Co., Bloomington, Ill.
Jewell Nursery Co., Lake City, Minn.
Knight & Bostwick, Newark, N. Y.
Knox, S. H. & Co., Buffalo, N. Y.
McGlennon & Kirby, Rochester, N. Y.
McLean County Nurseries Company, Normal, Ill.
Miami Valley Nurseries, Phoneton, O.
Oregon Nursery Co., Salem, Oregon.
Perry Nursery Co., Rochester, N. Y.
Portland Nursery Co., Portland, Ind.
Prudential Nursery Co., Tippecanoe City, O.
Ridge Avenue Nurseries, Troy, O.
Ringler Rose Company, 1112 Rector Bldg., Chicago, Ill.
Sherwood, Elmer, Odessa, N. Y.

Sidney Nurseries, The, Sidney, O.
Spring Hill Nurseries, Phoneton, O.
Standard Nursery Co., Rochester, N. Y.
Stark Bros. Nurseries & Orchards Co., Louisiana, Mo.
Van Dusen Nurseries, The, Geneva, N. Y.
Western New York Nursery Co., Rochester, N. Y.
Whitney, G. W. & Co., Dansville, N. Y.
Willett & Wheelock, North Collins, N. Y.

Respectfully submitted,
L. R. TAFT,
State Inspector of Nurseries and Orchards.

East Lansing, Michigan,
June 30, 1909.

TWENTY-SECOND ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH ACT

FOR THE

YEAR ENDING JUNE 30, 1909.

For members and organization of the State Board of Agriculture in charge of the Station and list of officers, see page 11 of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1909:

		Dr.	Cr.
July 1, 1908—	To balance	$7,929 92	
July 18, 1908	received from U. S. Treasury	6,500 00	
Oct. 12, 1908	received from U. S. Treasury	6,500 00	
Jan. 12, 1909	received from U. S. Treasury	6,500 00	
Apr. 6, 1909	received from U. S. Treasury	6,500 00	
June 30, 1909	license fees, 190 brands com'l fertilizers and 1 analysis	3,802 50	
	farm receipts, etc	1,545 95	
	from State appropriation, South Haven	1,500 00	
	from State appropriation, U. P. Experiment Station	3,000 00	
	South Haven Experiment Station receipts	431 42	
	U. P. Experiment Station receipts	227 49	
	by disbursements as per vouchers filed in the office of the State Auditor General		$42,802 96
	Balance on hand		1,634 32
		$44,437 28	$44,437 28

Two hundred two thousand regular bulletins, thirty thousand special bulletins and one hundred fifty thousand circulars have been issued and paid for by the State during the past fiscal year.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

	Hatch Fund.	Adams Fund.	Total.
Salaries:			
Director and other administrative officers; clerks, No. employed 4	$1,857 90		
Scientific staff, No. employed 4	2,490 11	$1,499 60	
Assistants to scientific staff, No. employed 14	2,968 61	5,261 80	$14,078 01
Labor:			
Monthly employes	$1,735 47		
Weekly, daily and hourly employes as needed	2,315 33	$338 59	4,389 39
Publications:			
Halftones, mailing lists, etc	$272 75		272 75
Postage and stationery:			
Postage	$172 46	$16 33	
Stationery	89 95	75	
Telegraph and telephone	1 75		281 24
Freight and express	$102 78	$37 66	140 44
Heat, light, water and power	$47 16		47 16
Chemical supplies:			
Chemicals	$191 60	$157 87	
Other supplies	162 94	308 76	821 17
Seeds, plants and sundry supplies:			
Agricultural	$187 09		
Horticultural	309 09		
Botanical	58 00	$55 02	
Entomological	34 80	28 06	
Bacteriological	20 78	116 62	
Chemical	29 98		
Director's office	12 25		
Office secretary	16 39		
Veterinary	15		868 23
Feeding stuffs	$23 62	$174 68	198 30
Library:			
One set Genera Insectorum	$44 21		
One set Genera Insectorum	32 70		
One set Genera Insectorum	41 20		
One Index Kervenis Suppl III	7 21		
One Index to N. A. Micology	3 25		
One Archiv feur Hygiene	18 75		
One Brocheniesches Centralblatt	10 02		
One Brocheneisches Zeitschrift	18 00		
One Zeitschrift feur Hygiene Vol. 60	16 50		
Other purchases	343 10	$15 28	550 20
Tools, implements and machinery:			
New purchases	$34 94	$2 48	
Repairs	15 09		52 51
Furniture and fixtures:			
One flat top desk	$15 00		
One hektograph	4 50		
One table	17 00		
One cabinet and drawers	29 70		
Other purchases	41 00	$1 00	
Sections for case	....	17 25	125 45

U. S. APPROPRIATION.—*Concluded.*

	Hatch Fund.	Adams Fund.	Total.
Scientific apparatus:			
One Wondenser comb	$125 50		
One thermometer	6 00		
One poney presno No. 6	37 00		
One mirror	20 00		
One germinating chamber	85 00		
One dictionary	23 00		
One microscope	85 00		
One atomizer	5 00		
One thermometer	50 00		
One thermograph	75 00		
One case		$14 00	
Four jars		22 00	
One doz. clenicals		10 00	
One microscope		44 00	
Twenty-five lbs. mercury		22 00	
Three microscopes complete		276 90	
Two soil thermometers		12 60	
One century camera		83 30	
One vacuum drying apparatus		148 00	
One vacuum distilling apparatus		150 00	
178.5 Grms. platinum		173 15	
Ten resistance tubes, etc		165 80	
Other purchases	93	321 47	
			$1,956 15
Live stock:			
Swine		$861 25	
Sundries		22 62	
			883 87
Traveling expenses:			
In supervision of station work	$73 11		
In connection with investigations under the Adams Act		$151 66	
For other purposes connected with station work	534 62		
			759 39
Buildings and lands:			
Improvements	$86 24	$442 00	
Repairs		47 50	
			575 74
Total			$26,000 00

DISBURSEMENTS OF EXPERIMENT STATION MONEYS—OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$2,902 46	
Labor	5,205 08	
Publications	77 51	
Postage and stationery	325 89	
Freight and express	526 15	
Heat, light, water and power	2 16	
Chemical supplies	92 62	
Seeds, plants and sundry supplies	1,390 50	
Fertilizers	100 00	
Feeding stuffs	2,854 77	
Library	35 04	
Tools, implements and machinery	13 00	
Scientific apparatus	16 75	
Live stock	827 00	
Traveling expenses	1,411 43	
Building and lands	1,022 60	
		$16,802 96
Balance		1,634 32
Total		$18,437 28

REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION.

President J. L. Snyder:

At the beginning of the fiscal year, July 1, 1908, several changes were made in connection with the Experiment Station organization. Prof. H. J. Eustace was made Experiment Station Horticulturist and Prof. L. R. Taft, Consulting Horticulturist. Prof. J. A. Jeffery was made Soil Physicist and has carried on some work in connection with one of the Adams projects throughout the year. Later in the year Dr. Beal was appointed to the position of Botanist of the Experiment Station with Dr. J. B. Dandeno as assistant in the same. The Dairy Husbandry Department was given official representation in Experiment Station work through the appointment of A. C. Anderson as Assistant Dairy Husbandman and a member of the advisory staff. In the same way Animal Husbandry was represented by the appointment of H. W. Norton, Jr. to a similar position. Heretofore the lines of work which have been carried on in connection with the Farm Department of the College, in which investigation work has been in progress, have not received representation in the Council or Station Staff and it seemed highly desirable that this recognition should be granted to these departments.

A new classification of Experiment Station publications was brought into use at the beginning of this year. The following are the classifications under which publications are now issued:

First, Popular Bulletins, embodying such publications as are of general interest to the farmers of the state, dealing, as they do, with ordinary practices. These are sent out to the entire mailing list, which now comprises about 55,000 names.

Second, Special Bulletins. This list comprises those that are of local interest only, such, for instance, as sub-station reports, or other publications which deal with questions of interest only to people of a limited area.

Third, Technical Bulletins, consisting of the reports of scientific research work such as is carried on in connection with the Adams projects, and in some cases they are suited only for the use of men actually engaged in similar lines of work. They may also consist of reports of progress made in connection with research work. It is not believed that this class would be of interest to the farmer generally, but both technical and special publications can be secured, by all who desire to procure them, by addressing a card to the mailing department of the Experiment Station. Mention of the issue of special and technical publications will be made in connection with the regular publications so that notice will be given to all.

Fourth, Circulars. This group consists of four to six page publications dealing with practical topics upon which there seems to be a general demand for information. In many instances this demand is determined through inquiries which come to the various offices of the Experiment Station. The idea is to produce a brief, plain, simple, practical publication which will relate to one specific subject only, that may be directly helpful to the farmers.

Fifth, Press Bulletins. For several years the institution has been issuing from two to five hundred word articles to the press of the state. The object of this has been to disseminate information through the press to the farmers of the state, thereby getting it into their hands quickly in case of emergency as the demand may arise through special causes.

During the year the following publications have been issued by the Experiment Station:

Bulletin No. 252—Fertilizer Analyses by A. J. Patten, S. L. Jodidi and C. B. Collingwood.

Bulletin No. 253—Can the General Farmer Afford to Grow Apples and Suggestions on Improving and Spraying Apple Orchards by S. B. Hartman and H. J. Eustace.

Bulletin No. 254—Preliminary Report on Wintering Farm Work Horses by H. W. Norton, Jr.

Bulletin No. 255—Cement Silos in Michigan by J. A. Jeffery.

Special Bulletin No. 47—Corn Improvement (Revision of Special Bulletin No. 44) by J. A. Jeffery.

Special Bulletin No. 48—Report of the South Haven Sub-station by L. R. Taft.

Special Bulletin No. 49—Grape Spraying Experiments in Michigan 1907-8 by C. L. Shear and Lon A. Hawkins.

Technical Bulletin No. 1—Keeping Qualities of Butter—General Studies by Wm. S. Sayer, Otto Rahn and Bell Farrand.

Circular No. 3—Corn-selecting, Storing, Curing and Testing by J. A. Jeffery.

Circular No. 4—I. Methods of Breeding for the Improvement of Michigan Cattle. II. Organization of Cooperative Cattle Breeders' Associations in Michigan by R. S. Shaw and W. F. Raven.

Circular No. 5.—Innoculation with Nodule-forming Bacteria by Wm. S. Sayer.

Press Bulletin No. 19—The Formalin Treatment of Wheat for either Loose or Stinking Smut by J. A. Jeffery.

Press Bulletin No. 20—The Formalin Treatment of Oats for the Prevention of Smut by R. S. Shaw.

Press Bulletin No. 21—Potato Scab—Ways of Prevention by H. J. Eustace.

Owing to the fact that no Experiment Station funds were used in conducting experimental work in connection with the Departments of Animal Husbandry, Dairy Husbandry, Poultry, Farm Mechanics and Farm Crops, mention will be made of the work carried on in these departments in connection with the report of the Dean of Agriculture. During the year special state funds were available for live stock experimental work and also work in connection with the poultry department. This has been true in the past four years, but the results of the experimental work derived in this way have been turned over to the Experiment Station for publication when completed, and a somewhat complete description of these lines of work will, therefore, be given in connection with the report of the Farm Department.

The work of the Experiment Station is quite fully covered by the heads of the various departments with one exception. The experimental work in Crops has remained under the direction of the director of the Experiment Station but has been in charge of Mr. F. A. Spragg. This work has been developed almost solely along lines of crops breeding, dealing with corn, cereals, pasture and forage crops, et cetera. The following is a statement descriptive of the line of work. The aim has been to develop pure or pedigreed strains of the field crops. The department handles between one and two hundred thousand individual plants annually, from which superior individuals are selected for use in starting new selection plots, for eventual increase. The plants must have similar conditions of space, soil, moisture and sunshine, and when sufficient quantities of seed from strains superior in quality and uniformity, are procured they are put on a comparative basis to determine the yields. The next step is to select and increase the desirable ones and send them out to farmers.

Wheat—of the 222 living wheat plots, 50 are one-twentieth acre yield plots, 18 are one-hundredth acre increase plots, 16 are smaller increase plots, six are beds or selection plots in the first year and 138 are single selected plants originating in 1908. The increase plots originated with individual plants of 1906 and 1907.

Oats—of the 156 oat plots, 42 are one-twentieth acre plots, 23 are one-hundredth acre plots, 9 are beds and 82 are single selected plants of 1908. Twenty-six of the one-twentieth acre plots are planted from pure strains originating in single selected plants of 1906.

Barley, Flax and Timothy. These are being continued along the same lines reported last year.

Corn—But little has been undertaken in addition to the work reported last year. The cooperative experiments carried on among farmers throughout the state has been placed in charge of Mr. A. R. Potts.

Cow Peas—All the cow peas that have survived the selection process can be traced back to three of the numerous original varieties. However, as these original varieties were planted close together, many hybrids were produced and the work now is the development of new kinds.

A hybrid plant with black seeds selected in 1906 is of special interest. These seeds were planted in 1907 and the best individual plants selected. Some plants had produced uniform black seeds like the parent, others white seeds with black eyes, and still others bore seeds variously spotted. Only those producing uniform seeds were saved to continue the work in 1908, the blacks being planted in one group of plots and the black-eyes some distance away.

In the group of blacks, two plots attracted considerable attention as being high producers, one of seed and the other of forage. The heavy seed producer was a bush type with uniformly black seeds which is being increased this year so that perhaps some seed may be sent out to farmers next year.

The different classes of these plants have been isolated between other crops so as to prevent hybridization and enable us to grow a large number of promising pure strains for comparison of yields and general value.

We have a pure strain originating from a single plant of 1906 that proves to be a good forage producer and a fair seed producer which is being increased to send out next year.

These two increase plots of this year are the first cow peas we have been able to produce which could be recommended for Michigan conditions.

Soy Beans—The breeding work has been completed and we have quite a number of pure strains that are being tested out in variety series.

Clover—As it is situated on stiff soil, the winter-kill in the clover nursery was very heavy. Perhaps it is a good thing to have the plants thus severely tested as the survivors undoubtedly belong to hardy strains. The individual plants in the nursery were set in check-rows two feet each way. Second generation nurseries of the mammoth, June and alsike clovers will be set out this year. The seed is growing in beds this year, having been grown from a selected high-producing mother-plant of last year. The new nurseries will be set out about the last of June and will probably contain 4,500 individual plants.

Alfalfa—Our nursery contains individual plants from over a hundred sources and new alfalfas are being received each year. As Michigan does not produce alfalfa seed, the main object of this work is to select the best from the best through a number of generations until we have strains that will be high seed producers as well as producers of large quantities of hay. Some of the families did not lose a single individual plant by frost last winter, and the plant which produces the greatest amount of seed is still alive.

R. S. SHAW,
Director.

East Lansing, Mich., June 30, 1909.

REPORT OF THE BACTERIOLOGIST.

Director R. S. Shaw:

Dear Sir—Progress is indicated along the several lines of investigations under way in this laboratory. Only specific comment can furnish the trend of work or results.

BUTTER INVESTIGATIONS.

Last year were issued the findings on the "Keeping Qualities of Butter" by Wm. S. Sayer, Otto Rahn, and Bell Farrand. This year the work has continued and all efforts have been concentrated upon the influence of salt, and of nitrogen in their relations to these keeping qualities. The able and active control of Dr. Otto Rahn in conducting this work is largely instrumental in bringing the work to its present status. Associated with Dr. Rahn, has been Mr. Charles W. Brown, who has so conscientiously pursued the study of the bacterial nitrogenous products, and who will assume charge of the work for the coming year. Also, Miss Lulu M. Smith has assisted by taking the patient rôle of following the life-histories of the micro-organisms involved and of ascertaining the strictly biological relationships to the keeping of butter. It is the purpose of this laboratory to persist in this work until the keeping qualities of butter are placed upon a more definite basis, a basis which will enable the butter-maker to know the exact factors at work and to eliminate those which interfere so materially with good quality.

TYPHOID FEVER GERMS IN MILK.

Owing to the close association of epidemics of typhoid fever and milk, as well as milk products, the question has been asked several times, whether the typhoid germs would withstand the acidity of ordinary soured milk. To ascertain the influence of sour milk upon the typhoid germs, Miss Zae Northrup has undertaken investigations. Seemingly easy, results would be expected early, but, on the contrary, many difficulties have been encountered, because of a lack of satisfactory methods in isolating readily the one germ from the other. Again, it has been found advisable to include as many types of lactic bacteria as are available for study lest the results from one type might not be indentical with those of another.

The problem has, therefore, resolved itself into a study of devising methods to make the various determinations of typhoid germs in the active presence of many types of lactic bacteria.

SOIL INVESTIGATIONS.

Bacteriological soil investigations are receiving considerable prominence as time goes by. It is believed that the micro-organisms of the soil are to a large extent responsible for the difference between an active fertile soil and an inactive or dead soil. When Mr. Walter G. Sackett entered this laboratory, soil studies were undertaken in earnest. His attention was given to the study of the action of micro-organisms upon the insoluble phosphates of the soil. Before leaving us, he, in association with our Chemist, Mr. A. J. Patten, gave his results in bulletin form. Upon his departure, Mr. Wm. S. Sayer undertook the work. This was September 1, 1908. Mr. Sayer entered upon the work in a comprehensive and thorough manner. He studied his problem in its relation to all the recognized problems of the soil, and made a serious and systematic effort to master his subject. He attended the summer graduate school for Experiment Station workers for the purpose of familiarizing himself with the work of others. He waded through soil literature to learn what investigators had already contributed; in short, he was leading up to his problems in a careful systematic manner so characteristic of the man.

WORK WITH LEGUME CULTURES.

Mr. Bronson Barlow, for the last four years connected with the Bacteriological Department of Guelph, Ontario, came to this laboratory for a short time about the first of March. Together with Mr. Sayer, he instituted the methods for providing cultures for legumes to farmers, such as had been done at Guelph. Mr. Barlow left the laboratory early in April, when this entire work devolved upon Mr. Sayer. On the evening of April 30, 1909, Mr. Sayer was drowned in the cedar river while canoeing.

The nodule-forming bacterial cultures have been, since May 1st, under the direct care of Mr. Brown. I append a detailed report of what has been done in sending out these cultures. The actual forwarding began about April 1st, and the report closes June 25th. We are still sending out a few each day.

No. cultures alfalfa, sent out	392
No. cultures red clover, sent out	172
No. cultures alsike clover, sent out	23
No. cultures white clover, sent out	7
No. cultures soy beans, sent out	15
No. cultures white beans sent out	172
No. cultures peas, sent out	64
No. cultures cow peas, sent out	20
No. cultures vetch, sent out	7
Total	872

Fifty-three cultures have been sent to institutions and to individuals for experimental purposes.

These cultures were sent out upon request made upon the following form of application.

APPLICATION FOR NODULE-FORMING BACTERIA.

I desire to conduct an experiment with nodule-forming bacteria for:—

Alfalfa, red clover, alsike clover, white clover, beans, soy beans, peas, cow peas, vetch.

(Strike out those not wanted.)

Pounds (or bushels) of seed to be inoculated?......................

(Each bottle is sufficient for 60 lbs. of seed.)

Probable date of seeding? ....

If the culture is sent to me, I will,—

1. Carry on the experiment according to the instructions received.
2. Exercise care and accuracy in the work.
3. Report the results of the experiment soon after harvest, whether successful or not.

Name................................

County..................................

Postoffice...............................

State..................................

A nominal charge of 25 cents per bottle is made to cover cost of material and shipping.

Enclosed find........................cents.

This sheet when filled out should be addressed in a sealed envelope to the *Bacteriological Laboratory, East Lansing, Michigan.*

With each culture were sent directions for using the culture and a blank report upon which the farmer can make the report of results. They follow herewith:

DIRECTIONS FOR USING CULTURE.

This culture is sent to you with the understanding that you will use it according to directions and report to us your success or failure. The price of the culture is 25 cents.

1. Cover the seed with water and let it soak for an hour.
2. Mix a pound of granulated sugar with each bushel of wet seed. (This step is advised but it can be omitted.)
3. Spread the seed in a clean place until dry enough to plant.
4. Pour a little cool water into the bottle of culture, break up the culture with a clean stick and mix it with the seed.
5. If the seed is still too wet and sticky to plant, it may be spread out again in the shade. It should be neither wet nor dry, but as moist as it can be and yet seed evenly. Plant the seed just as you would untreated seed.
6. Do not open the bottle until you are ready to treat the seed, and treat only as much seed as you can sow in a day.
7. A small strip should be planted with uninoculated seed for comparison *and this should be seeded first.*
8. Put a sample of uninoculated seed in one of the small envelopes and a sample of inoculated seed in the other and return to us in the addressed envelope.

Address,
BACTERIOLOGICAL LABORATORY,
East Lansing, Mich.

REPORT ON SEED INOCULATION.

Name..
Address..
Kind of seed ....
Pounds of seed planted without culture..................................
Seed planted with culture ....
Nodules on untreated seedlings..
....
Vigor of growth with untreated..
....
Vigor of growth with treated..
....
Character of soil ....
Previous crops ....
Was your crop benefitted by the treatment?..............................
Do you want to try it again next year?..............................
Further observations ....
Did you find the treatment easy of application?..............................

Address,
BACTERIOLOGICAL LABORATORY,
East Lansing, Mich.

With the return of reports, we are hoping that we shall be in position to judge of the need of legume inoculation here in Michigan. Reports from Canada, New York, and Virginia are so flattering that we feel much may be gained by the treatment; however, we are prepared to be disappointed. The Circular (No. 5) prepared by Wm. S. Sayer and published elsewhere in this report gives concisely our attitude toward the problem. Only by extensive trials can we expect to ascertain the real situation in Michigan.

BRIEF SKETCH OF THE LIFE OF MR. WM. S. SAYER.

Mr. Wm. S. Sayer was born on a farm near Wayne, Ill., Jan. 13, 1876. His education consisted of the common school training until he entered the Academy in Elgin. All of this time, he made his home on the farm. After finishing his Academy work, he entered Beloit College from which he graduated. He then entered Chicago University where he remained till he had completed all of his post graduate work except his thesis. For a time, he was engaged in a study of the influence of the Chicago sewage canal upon the waters of the Mississippi river. After leaving the university, he was engaged as an expert scientist by two commercial firms of Chicago. He came to this laboratory just two years before his drowning. During this time, he had proved himself a very careful, painstaking investigator. His drowning was a great loss to the laboratory, and his agreeable presence will be difficult to replace. To mourn his death are his parents and two sisters, whose affections and future centered in this only son and brother. Although this college cannot mourn as parents and sisters, yet it mourns deeply with them and feels bitterly the loss which came so suddenly. *His thoughts were pure, his deeds were pure, his life was pure—the world mourns the loss of such.*

WORK WITH HOG CHOLERA.

Two years ago, investigations were begun in this laboratory upon hog cholera. At that time, our attentions were centered in an effort to establish a connection between B. cholerae suis and hog cholera, believing that, in reality, the etiological factor represents the key to the situation, for until the cause of hog cholera can be isolated and handled as a distinct entity, more or less indefiniteness must enshroud all attempts in its satisfactory management. This work was carried as far as it was possibe for that year. At the close of the year, the Bureau of Animal Industry demonstrated the Dorset-Niles serum prepared by the Turner-Kolle method applied to rinderpest. This treatment appeared so promising that the preparation was undertaken at once. This introduced many new and complex problems, because of the fact that its use had been very limited. So numerous were these unsettled questions that it became impossible to follow any exclusively; it was necessary to serve the applied end, in order to keep the work under way. This has resulted in a year of chaos, so far as hog cholera investigations are concerned—much started and little settled. However, even in this chaos of manufacture and undetermined question, Dr. Giltner has contributed much additional work along the lines started two years ago. Some of these results will be embodied in a short bulletin which is now in manuscript form. Others will be published later.

After the demonstration of the "Bureau" serum at Ames in May, 1908, several states undertook its manufacture. Michigan was the first to put serum into the field. About the 20th of August, the laboratory had serum ready for use. The results were so gratifying that we decided to place it upon a commercial basis, and to charge sufficient to cover its cost. Its expensiveness precludes sending it out free of charge.

Accordingly, it was decided to charge two cents for each cubic centimeter. Furthermore, in the treatment of animals, there is always a possibility of reverses. In order to shield the college from trouble, a contract was exacted relieving it from all responsibility. The following contract is agreed to by the owner of every herd of swine treated.

HOG CHOLERA TREATMENT.

Name.....................................

Address.....................................

Date..........................No. of mixed serum used............

Amount...........................No. of virus used..............

AGREEMENT.

The Bacteriological Laboratory of the Michigan State Agricultural College in no manner guarantees the efficacy of the vaccination of hogs against hog cholera or any other disease by the simultaneous injection of hog cholera virus and serum or serum alone (prepared for the purpose of modifying the action of said virus). The laboratory can assume no responsibility whatever for this treatment or vaccination of hogs against hog cholera or any other disease. So far as the bacteriological laboratory is concerned, the merits of the treatment or vaccination, as at present established, must be the sole recommendation for its use.

Any one wishing his hogs treated or vaccinated with the virus and serum must agree to the above conditions and must promise to pay ....cents per cubic centimeter for the virus and.......... cent per cubic centimeter of the serum to the Secretary of the Michigan Agricultural College.

CHARLES E. MARSHALL,
Director of the Bacteriological Laboratory of the Michigan Agricultural College.

I agree to the above conditions and promise to pay on or before .... 19...., ...cent per cubic centimeter for virus and.............cents per cubic centimeter for serum for treating or vaccinating my herd of hogs, the amount to be stated in writing by the person conducting the treatment or vaccination. I further agree and promise to report the results of the treatment or vaccination to the Director of the Bacteriological Laboratory once each week for four weeks.

Signed.............................

Place .... Date ....

Signed............................
[Signature of Operator.]

Amount of virus used in cubic centimeters............................

Amount of serum used in cubic centimeters..........................

In the treatment of the herd of......................................

Signed............................
[Signature of Operator.]

NOTE.—The signatures must be placed before treatment and the amounts of serum and virus inserted after treatment is completed.

CONDITION OF HERD WHEN TREATED.

Condition of hogs when treated...

1. What portion of the herd has died..
2. Is the disease just beginning..
3. Does the disease appear to be generally disseminated...........
4. How long has the disease existed in the herd.........................
5. Does the disease exist on neighboring farms...........................

REPORT ON USE OF HOG CHOLERA SERUM AND VIRUS.

Name.. No. of contract..............................

Address.. Date..............................

Mixed Serum No.. Virus No..............................

Weight of pigs.	Number treated.	Number not treated.	Dose for each pig.		Number living.		Number sick.		Number dead.	
			Serum.	Virus.	Treated.	Not treated.	Treated.	Not treated.	Treated.	Not treated.
Sucking pig										
30—50 lbs										
50 – 75 lbs										
75–125 lbs										
125-175 lbs										
175–225 lbs										
225-275 lbs										
275–325 lbs										
325–375 lbs										
375–425 lbs										
425-475 lbs										
475 lbs. and above										

Bacteriological Laboratory, East Lansing, Mich.

Besides the contract, we have felt the need of explanations and directions. To meet this want Dr. Giltner prepared the following article:

DIRECTIONS FOR USING HOG CHOLERA SERUM AND VIRUS.

Serum and virus are prepared by the Bacteriological Laboratory of the Michigan Agricultural Experiment Station for the treatment of hogs for the prevention of hog cholera.

The Bacteriological Laboratory does not recommend "Hog Cholera Serum" as a curative or remedial agent for hogs already suffering from hog cholera. Laboratory does recommend the use of "Hog Cholera Serum and Virus," prepared according to the method used by the Bureau of Animal Industry, as the only known preventive of hog cholera. Nothing is guaranteed. Michigan farmers must base their decision to use or omit the use of "Hog Cholera Serum and Virus" upon its merits as established by field tests. (See contract.)

"Hog Cholera Serum" is a preventive of *hog cholera* only. It can not be expected to prevent hogs from dying or becoming sick from any other infection than that of *hog cholera* or from the disorders caused by intestinal or other parasites. "Hog Cholera Serum" can not replace proper care and feeding of swine or save hogs from dietary troubles other than those caused by the *virus of hog cholera.*

The following directions and precautions must be carefully observed in order to avoid bad results for which the serum and virus should not be held responsible.

METHOD OF TREATMENT.

"Hog Cholera Serum" or "Hyperimmune Serum" is the blood drawn from cholera-immune hogs that have been hyperimmunized or treated with large quantities of hog cholera virus subcutaneously or intravenously. This blood is defibrinated or whipped to remove the clot and contains a small amount of carbolic acid as a preservative. It contains no living germs capable of producing an infectious disease in hogs. It should be kept in a cool (30° 40° F.), dark place where it will retain its potency for some time.

"Hog Cholera Virus" or disease-producing blood is blood drawn from hogs killed at a certain stage of the disease. It is secured only at the laboratory under aseptic and antiseptic conditions, defibrinated and stored in sterile vessels at a low temperature. It rapidly undergoes putrefaction at room temperature and should not be used after it is several days old. It should be used immediately upon its receipt and any portion not used should be mixed with a disinfecting solution and the vessels containing it washed with a disinfecting solution.

There are two methods used in treating hogs for the prevention of hog cholera, viz: the "Serum-Simultaneous Method," and the "Serum Alone Method."

"Serum-Simultaneous Method:" Each pig is injected according to the methods described below with the proper doses of "Hog Cholera Serum" and "Hog Cholera Virus." The injections are made "simultaneously" or at the same time before the pig is released. This method is used in herds in which the disease does not exist or where the disease has just started. Pigs treated by this method are immune for six months to one year or perhaps for life. The method is not dangerous as a rule, but it is attended with greater danger than the "Serum-Alone Method." However, the resulting immunity is much longer than in the case of the "Serum-Alone Method" and the additional expense is not to be considered. Pigs that show an elevation of temperature or any other symptoms of hog cholera, or pigs that have been exposed to infection longer than one or two days are treated by this method at some risk.

"Serum-Alone Method:" Each pig is treated with the proper dose of serum *only*. This method is to be used in herds where the disease already exists and is to be used on healthy pigs only. The earlier in the outbreak it is used, the greater the number of animals that may be treated with prospects for a successful outcome. Pigs already sick will probably not benefit by its use. Many pigs, apparently well, but already infected with the disease germs, can not be saved by the use of serum, although a number of them may be saved. Serum alone may be used on pigs that it is desired to show at fairs or other public places for a short time where they may be exposed to infection. However, the "Serum-Simultaneous Method" is recommended for all healthy pigs. The "Serum-Alone Method" is in no way dangerous to the treated animals or to those associated with the treated. It is followed by a very short period of immunity lasting only one to three months.

Neither method is, as a rule, followed by any unfavorable symptoms. except a slight, transitory stiffness in the hind legs, and possibly a slight fever and lack of appetite for a short time, provided the animals were sound when treated.

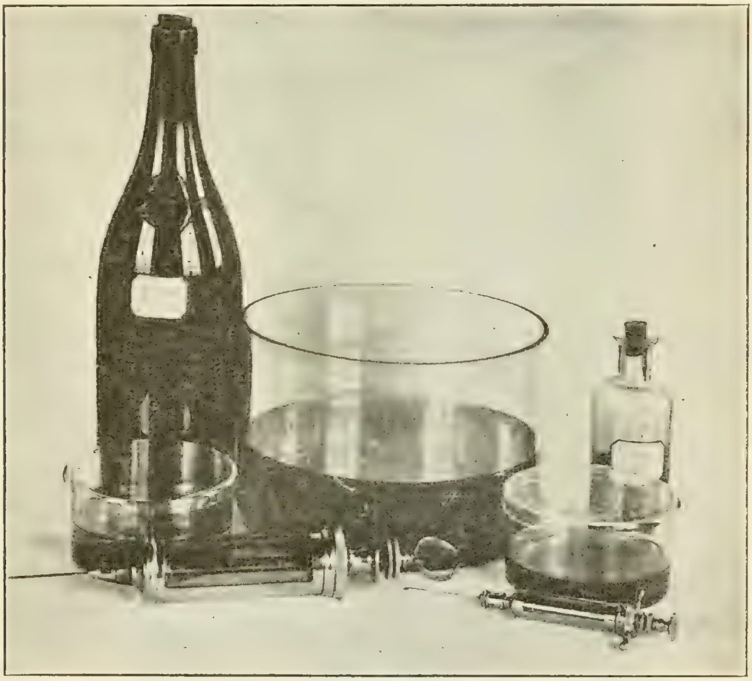

Fig. I. Showing apparatus and instruments for immunizing pigs against hog cholera. Materials for serum, on the left; and for virus, on the right of large dish of disinfecting solution.

DIRECTIONS FOR TREATING PIGS.

The following instruments and apparatus are required for treating pigs by the "Serum-Simultaneous Method:" (See Fig. 1).

(A) Bottle of serum; covered dish for holding serum (a clean, tin-covered jelly tumbler will answer), a hypodermic syringe with cc. graduations, capacity 50-60 cc.

(B) Bottle of virus; covered dish for holding virus (smaller than that used for serum); a hypodermic syringe with cc. graduations, capacity 5-10 cc.; a dish of disinfecting solution and cloth.

For treating pigs by the "Serum-Alone Method" only the materials mentioned under (A) are required.

PREPARING HERD FOR TREATMENT.

Separate the well from the sick or those to be treated from those not to be treated. If possible, mark in some way all those treated or all those not treated so that the results of the treatment may be accurately estimated. The pigs to be treated should be separated according to weight in pens or enclosures, all those requiring the same dose of serum being placed together.

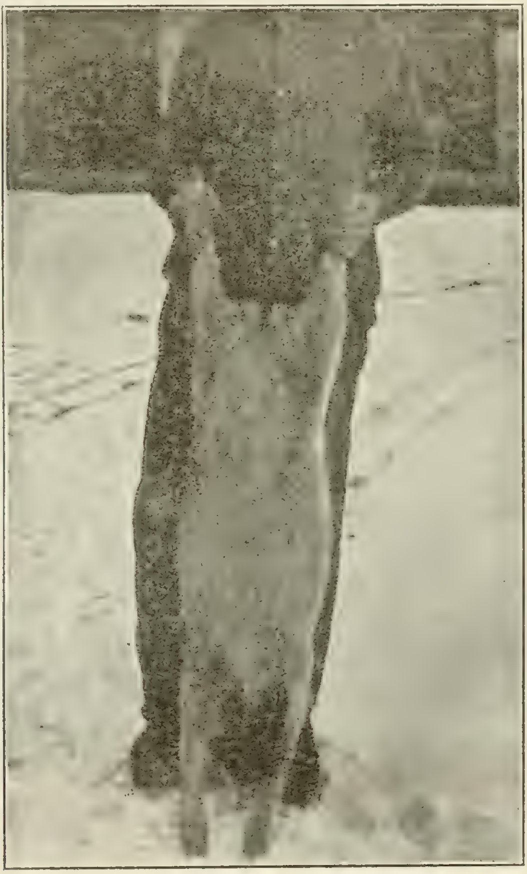

Fig. II. Showing method of holding pigs weighing less than 100 lbs. The crosses (+) mark the site for inserting the needles.

HOLDING THE PIGS.

The attendant holds the pig by the hind legs with the snout toward the ground and the inside of thighs or hams exposed to the operator. (See Fig. II).

Pigs weighing less than 100 lbs. can be easily held in this way. Larger hogs may be thrown on the back with the hind legs spread apart and held securely. Hogs weighing over 200 or 300 lbs. can be treated while standing by inserting the hypodermic needle into the muscles on the inside and back portion of the ham approaching the hog from the rear. An assistant holds the hog firmly by the tail. A "hogholder" or rope with slip-noose may be placed over the hog's upper jaw, the rope being then snubbed to a fence post. The treatment is not painful to the pigs which usually cease resistance while the injection is taking place.

TABLE OF DOSES FOR SERUM AND VIRUS.

NOTE.—The serum from a number of hogs is mixed and tested thoroughly before sending out. Such a mixture of blood is designated thus: Mixed serum No.....

The virus is secured from the pigs sick of hog cholera and is numbered according to the pig from which it is drawn, thus: Virus No...., or Virus Experiment No.... The doses of different batches of serum and virus will vary only slightly. A maximum and minimum dose is given and when each serum and virus is sent out, directions will accompany whether to use the maximum or minimum dose.

Weight of pig.	Dose of serum.		Dose of virus.	
	Minimum.	Maximum.	Minimum.	Maximum.
Sucking pig	10 cc.	15 cc.	.5 cc.	1. cc.
30–50 lbs	15 cc.	20 cc.	1. cc.	1.5 cc.
50– 75 lbs	20 cc.	25 cc.	1.5 cc.	2. cc.
75–125 lbs	25 cc.	30 cc.	2. cc.	
125–175 lbs	30 cc.	35 cc.	2. cc.	
175–225 lbs	35 cc.	40 cc.	2. cc.	
225–275 lbs	40 cc.	45 cc.	2. cc.	
275–325 lbs	45 cc.	50 cc.	2. cc.	
325–375 lbs	50 cc.	55 cc.	2. cc.	
375–425 lbs	55 cc.	60 cc.	2. cc.	
425–475 lbs	60 cc.	65 cc.	2. cc.	
475 lbs. and larger	65 cc.	70 cc.	2. cc.	

Do not underestimate the weight of pigs for the sake of saving the price of a few cc. of serum. There is much danger in using too little serum, little danger in using too much.

Place the apparatus during the treatment where it will be readily accessible, free from dirt, and free from danger of destruction by farm animals running wild.

Do not use *serum* for *virus* or *virus* for *serum*.

Use separate syringes for *virus* and *serum*.

Measure *serum* and *virus* in the syringe accurately for each hog. The syringes used should be previously tested with water to determine whether they are discharging the proper amounts.

When injecting material, plunge needle deeply into the muscles on inside of thigh (See + in Fig. II) perpendicular to the skin and avoid striking a bone. Inject the large volume of serum slowly and steadily, and, when removing the needle, place the finger over the point where the needle enters the skin, thus temporarily preventing return of serum through the puncture wound. Do not try to inject the material just under the skin as is customary in hypodermic injections.

Use a slip needle of rather small calibre.

NOTE.—Needles are frequently broken off in the flesh and should be removed when possible, i. e., when they can be secured before becoming buried under the skin. A local abscess usually results upon failure to remove a broken needle.

Make it a practice to inject serum on the left side and virus on the right side so that, if local trouble results, it can be attributed to its proper source.

In case of leakage due to stoppage of needle or other causes, be sure that the proper amount of serum and virus is introduced before the pig is set free.

It is well to wipe off the point of inoculation of the virus with a cloth dipped in disinfecting solution after injection.

Permanent separation of sound from affected animals and thorough disinfection of premises are advisable, but not mandatory.

The price of serum and virus at present is at the rate of two cents per cc. for serum and one cent per cc. for virus.

Do not fail to make out contracts in duplicate, filling in all blanks and adding any details of interest. Return one contract, report once each week as to results, and address all communications to,

BACTERIOLOGICAL LABORATORY,
East Lansing, Michigan.

We now think that we are in position to produce a circular which will set forth the value of serum for checking hog cholera outbreaks, but shall not recommend the use of virus unless employed by our own hands. In other words, we can recommend the "Serum-Alone" method as one quite free from danger and capable of checking the disease in most herds, but the "Simultaneous Method" we do not recommend, because it is too dangerous to use indiscriminately at the present time. We, hope, however, that the latter method can be perfected, because it is the better method.

The results for the year may be set forth in the following table. On the whole, they may be regarded as very satisfactory, but there are some disastrous results which may or may not be accounted for. From July till the middle of November our results were uniformly satisfactory—as satisfactory as can be expected from serum under all conditions. About the middle of November, a cold wave came on, and a new lot of serum was employed. We received our first check. The material was used upon five herds. During the winter, we learned that poor serum can be produced unless certain features of manufacture are watched very carefully, and even when they are carefully watched. Again, cold weather and the individual variation in swine affect the manufacture of a serum as well as the treatment. To avoid disastrous results, we now test out as best we can every lot of serum, and also do not recommend its use in cold weather, unless necessity drives us to some treatment. Herewith, I append the table prepared by Dr. Giltner.

Herd.	Date of treatment.	No. of animals treated.	No. of animals alive.	No. of animals dead.	Condition of herd when treated.
1.	8/14/08	39	9	30	All sick but one boar which is O. K. now.
2.	8/18/08	13	8	5	All very sick except one boar, which never became sick.
3.	8/22/08	51	51	0	Just starting; eight checks not treated, died.
4.	8/22/08	33	33	0	Had lost over half herd. Four sick pigs, not treated, died.
5.	8/22/08	11	11	0	Had lost over half herd. Four sick pigs, not treated, died.
6.	8/24/08	6	6	0	Never lost any; one check, not treated, became sick.
7.	8/24/08	27	16	11	Several in dying condition. Many treated were sick.
8.	8/27/08	55	55	0	Lost two; killed several, several sick, not treated, died.
9.	9/ 2/08	117	116	1	Disease had existed on farm for two years previous.
10.	8/21/08	12	12	0	Twelve shoats vaccinated and introduced into sick herd.
11.	....	60	55	5	Do not know condition of herd.
12.	During 4 months..	45	38	7	Susceptible animals immunized for serum.
13.	9/12/08	1	0	1	Sick pig treated for five days with serum.
14.	9/25/08	7	4	3	Disease existed in herd. Sucking pigs.
15.	9/25/08	23	9	14	Old sow very sick. Sucking pigs affected.
16.	9/26/08	7	7	0	See No. 4.
17.	9/26/08	28	24	4	One sow sick and young pigs ailing.
18.	9/26/08	18	9	9	Sick hogs on place. Disease just started.
19.	9/26/08	5	5	0	No disease on farm.
10.	10/ 4/08	21	21	0	Over half herd sick or dead. Treated, some sick.
21.	10/ 4/08	15	9	6	Disease had existed nearly two weeks.
22.	10/ 3/08	30	13	17	Disease had existed three weeks. Lost 10%.
23.	10/ 5/08	77	38	39	O. I. C. show herd. Badly diseased. Lost over 10%.
24.	10/ 8/08	67	45	22	Badly diseased. Was losing hogs every day.
25.	10/ 9/08	55	50	5	In good condition. Just begun to lose.
26.	10/10/08	29	26	3	Berkshire show herd. Had lost only three. Others sick.
27.	10/10/08	43	30	(?) 11	(?) Disease in herd for a week. Had lost three pigs.
28.	10/12/08	69	64	5	Berkshire show herd. Had lost two. Many were sick.
29.	10/15/08	165	163	2	Berkshire show herd. Had lost none. Disease existed.
30.	10/15/08	96	74	22	Disease in herd for a week. Had lost 16 pigs.
31.	10/15/08	19	17	2	Disease just begun.
32.	10/17/08	435	431	4	Had been losing more or less for nearly two years.
33.	10/18/08	13	0	13	Disease existed for one week. One sick.
34.	10/18/08	49	9	40	Disease in neighborhood. No disease in herd.
35.	10/18/08	13	3	10	Disease in vicinity. No disease in herd.
36.	10/19/08	22	12	10	Disease in herd for one week. One dead.
37.	10/19/08	33	21	12	Disease in herd for two weeks. Lost three.
38.	2/ 1/09	(?) 51	23	4	Disease widespread. Used *good* serum only. Prof. Good, Kentucky.

Herd.	Date of treatment.	No. of animals treated.	No. of animals alive.	No. of animals dead.	Condition of herd when treated.
39.	2/18/09	7	7	0	Disease on place last fall.
40.	3/19/09	1	1	0	At Berkshire congress.
41.	3/19/09	3	3	0	At Berkshire congress.
42.	3/19/09	1	1	0	At Berkshire congress.
43.	4/27/09	15	15	0	Had disease on farm last fall.
44.	6/ 5/09	11	11	0	No disease.
45.	6/ 5/09	24	22	2	Had disease last fall.
46.	6/ 1/09	24	24	0	Used serum only. Pigs, O. K.
47.	6/12/09	21	21	0	Had disease last fall.
48.	6/12/09	18	No report.	....	Had disease last fall.
49.	6/11/09	12	No report..	....	Had disease last fall.

In order to give some idea of the production of serum and the cost of manufacture, it may be desirable to enter into some details.

REPORT ON HOG CHOLERA SERUM MANUFACTURE.

July 1st, 1908, July 1st, 1909.

Feed—concentrated	$457 02
Straw and roughage	100 50
Swine	791 07
Travel	76 10
Labor (unskilled)	1,000 00
Cots	240 00
	$2,664 90

VALUE OF RECEIPTS AND PRODUCTS ON HAND.

Actual receipts	$657 62
Value of good serum for this year's campaign	1,861 68
Value of good *untested* serum	1,156 26
Value of swine in work at present	250 00
	$3,925 62
Deducting a possible loss of one-third untested serum	385 42
	$3,540 20

Leaving a balance of $875.30 to meet skilled labor, and wear and tear on laboratory plant and other expenses not incorporated in above list.

DETAILS.

Serum—

Sold, for which collections have been made	32,145 cc.
Used for testing and experiments	14,688 cc.
Sold for which the collections are outstanding	8,095 cc.
On hand—good	93,084 cc.
On hand—untested	57,813 cc.
On hand—poor	28,618 cc.
Total production	234,443 cc.

Virus—

Sold for which collections have been made	1,471.5 cc.
Used for testing and experiments	935 cc.
Sold for which the collections are outstanding	227 cc.
Used for hyperimmunizing swine	95,456 cc.
Used for inoculating in laboratory	131 cc.
Used for simultaneous vaccination in laboratory	300 cc.
	98,521.5 cc.

GRAND TRAVERSE DISEASE.

It was our purpose this year to carry out some work on the etiology of the Grand Traverse disease. Because of this fact, we have withheld a manuscript, considering this disease, prepared by C. D. Smith, former director of this station. The work on hog cholera has been so extensive and pressing that the Grand Traverse disease has been neglected, excepting some correspondence and a visit to that region by Dr. Giltner. After going over the situation, we have concluded to defer the studies on etiological factors until such a time as may prove whether the dietary recommendations contained in the bulletin will have the effect of correcting the trouble by the introduction of better methods of feeding. Should improved methods answer the purpose, that is the checking of the disease, then it will not be necessary to go further in the study, unless for the sole purpose of knowing what is the immediate cause.

CONTAGIOUS ABORTION.

For the past year, we have had some experience in fighting contagious abortion. It is unfortunate that there is no specific treatment for this trouble which probably causes more financial loss to the cattle owners of Michigan than any other disease. We have had in mind writing something formal for the benefit of the farmers, but we do not feel sufficiently secure in making any recommendations. The best we can do at the present time is to offer our plan of treatment which may check the disease, if thoroughly and conscientiously applied in most herd epidemics. There will be some disappointments, however, but persistency in following the treatment will aid much toward success.

We herewith append the treatment—a modification and compilation of several along the same lines.

TREATMENT OF CATTLE FOR CONTAGIOUS ABORTION.

1. *Feeding Carbolic Acid*—Begin by mixing 2 grams of carbolic acid (in 5% solution) with the grain fed for each cow. Allow this to continue for 5 days. At the end of 5 days, increase the amount to 5 grams (in 5% solution). At the end of 10 days, increase the amount to 7 gram (in 5% solution) and continue this for 20 days; stop for 20 days, then resume for 10 days; again stop for 20 days; then resume again for 10 days, and so on.

In case of suspects, this dose may be increased to 9 grams. In calves, reduce to one-half the amount.

2. *Suspected Cases.* In addition to No. 1, inject subcutaneously 30 cc. of a 2% solution of carbolic acid every two weeks.

3. *General Vaginal Treatment.* Irrigate vaginal tract with one-half per cent Liquor Cresolis Compositus (U. S. P.) once each week. In suspects every day or every other day, as the case may seem to demand.

4. *Disinfection of Bulls.* Use one-half per cent liquor cresolis compositus (U. S. P,) before and after service. Employ two quarts for each.

5. *Treatment of Aborted Cows.* a. Remove after-birth. b. Irrigate very thoroughly with 2% solution of Potassium permanganate. c. Follow *b* with one-half per cent liquor cresolis compositus (U. S. P.). d. Introduce one Peter's Capsule. b. c. d. every day for two or three days, then every other day. Increase the length of the intervals as the case will permit. Keep cows isolated for three weeks.

6. *Washing Cows.* Use 1:1,000 corrosive sublimate very freely.

OTHER ANIMAL DISEASES.

I am adding to my report the experiences of Dr. Ward Giltner who has been called upon, during the past year, to investigate several outbreaks among animals. His own descriptions of some of the outbreaks are herewith given:

POST MORTEM OF CATTLE ON FARM OF MR.————, SALINE, MICH.

February 26, 1909, a visit was made to Saline, Mich., to investigate cattle disease on farm of Mr.————. He had lost up to date seven head. The first one dying was an old cow (lost several teeth), dry, being prepared for butcher. All the others were young stock—older than suckling calves and none milkers. All cattle ran together and were fed same and exposed to identical conditions which were above criticism; pure water, best of hay, corn stover, shredded stalks and corn, oats and bran. Five milch cows remained free from disease and a veal calf remained well.

Cases in charge of Dr. Slaght with Dr. Waldron in consultation.

Sheep, horses, and swine kept in same barn and in intimate contact with sick cattle showed no signs of disease, dog and chickens also well. Neighbors had visited place constantly without personal losses.

At the time of visit, Feb. 26, 1909, there were three sick animals, five milch cows and two head of young stock unaffected with one well veal calf. One of the sick animals was a shorthorn bull (young); sick about ten days and appeared to be convalescing; temperature normal;

very lame in left hind leg in a. m., but seemed all right in p. m.; no appetite; sore mouth; muzzle dry and cracked with lateral fissures; slight lachrymation; had been slight, muco-purulent nasal discharge; temperature had been reduced from 106° and 107° to normal. This was the only case that showed signs of recovery.

Another of the three cases was a heifer calf less than a year old; sick about five or six days; slight muco-purulent nasal discharge, slight lachrymation and an opacity of the cornea of right eye with considerable precipitate in anterior chamber of eye; ate only very little; appeared dull; showed no pain; passed normal, firm feces during day and urinated normally; temperature, 106.8°.

The last of the three was a black yearling steer; sick about five days; three to five degrees of fever throughout; passed about a pint of liquid manure the day before, probably all that the bowels contained; no appetite; lachrymation abundant, purulent discharge from inner canthus of each eye; slight muco-purulent nasal discharge; very weak and hollow in flanks; made to stand with difficulty; temperature, 105.8°. Killed in p. m. Just before killing, blood was drawn from the right jugular vein with sterile canula into sterile bottle. A sluggish stream at first, quickly subsided into drops and the canula became filled with a clot before an ounce had been drawn; killed by blow over brain and cut throat.

Post mortem: Blood flowed readily from carotids and jugulars at first, but soon ceased. On removing the hide, immediately, the subcutaneous tissues below the carpal and tarsal joints was cold, there was some yellowish oedema in subcutem of brisket; all the subcutaneous vessels contained some blood and all the capillaries throughout the body on the membranes seemed to contain enough blood to make them visible; there were very numerous petechiae and ecchymoses in connective tissues upon cutting through pectoral muscles. The pericardial sac showed a few petechiae near its attachment to diaphram; the right ventricle was distended with a dark clot; lungs were pale except the dorsal portion which was considerably congested; all lymphatic glands were slightly odematous; the liver was very pale, almost parboiled in appearance, except for a few congested patches; the gall bladder was distended with about a pint of normal colored bile; the kidneys were normal; spleen, possibly slightly enlarged but normal color and firmness; bladder, partly full, urine normal; brain normal in color meninges pigmented black; possibly, brain substances, slightly softer than normal; nasal mucosa, only slightly congested; rumen, fairly well distended and contents normal; mucosa, normal; reticulum, normal; omasum, full and contents partly dry, mucosa, normal; abomasum nearly empty, mucosa, normal; the entire intestinal mucosa was congested more or less, in places the congestion extending through into submucosa and vessels of serosa injected; Peyer's patches congested especially; about three feet from the theovocal valve, the mucosa of ileum showed about one foot of considerable hemorrhage; the intestinal contents consisted of only a slight amount of nearly digested food adhering mucosa; the periostum of the bones was considerably congested and the marrow adjacent to the inner surface of the shaft of the bones was tinged with blood.

The examination of another cow that had been dead two and one-half days, and frozen in the woods, showed considerable hemorrhage in the small intestines with clots of blood mixed with the scanty ingesta. There also appeared a few hemorrhages in the muscles of the shoulder and hip regions.

In cows that died, the usual course of the disease was four to six days, moderate sustained febrile temperature not responding to treatment, dullness, no appetite, no thirst, diarrhea (usually), lachrymation, muco-purulent discharge slight from eye and nose, (not present in all), seldom any signs of pain.

Post mortem revealed about the same on all. Man had been on farm seven years, and never lost any before. Had not bought any recently, except a cow from a neighbor and that not until after the disease appeared.

Smears of blood show nothing abnormal.

Smears from clean, small intestinal mucosa, stained with Wright's Stain, show large number of rod-like bacteria, rounded ends, varying from oval to long, rods five to six occurring in chains of two to six, usually. If stained with carbol-fuchsin, they appear surrounded by a capsule and clear area.

Many eosinophile and few mast cells present in smears stained with Wright's Stain.

Cultures on agar slant show pure culture of feebly or non-motile rod about size of colon germ.

A letter from Dr. Slaght, March 15, 1909, stated that the bull and sick calf died, with no other cases up to date.

INFECTIOUS ANAEMIA OR SWAMP FEVER.

On Jan. 27, 1909, I was at Sault Ste. Marie, investigating an outbreak of hog cholera. Dr. Marshall had requested me to attempt to find out the nature of a disease among horses that had been reported as existing in the Northern Peninsula for several years.

Fortunately, Dr. J. F. Deadman was able to show me a case in his own hospital. This case was a mature, bay gelding. Had been under treatment for several weeks. The horse had first shown signs of great weakness, tiring very readily when put to work; became thinner daily, while appetite remained very keen; bowels remained free; urination excessive; temperature rose to 105°, but was brought to normal whenever it rose by large doses of acetanilid; there was cardiac hypertrophy; jugular pulse; slight oedema about the eyes and on ventral portion of body; the visible mucous membranes were very anaemic; the patient walked with a very uncertain gait, crossing the hind legs at each step; and emaciation was extreme at time of my visit.

Dr. Deadman had made no diagnosis, but considered the disease a severe anaemia and from the nature of the many cases that had come under his observation he was inclined to believe that the disease was infectious. He has reports of the disease having existed in the vicinity for over ten years. There is nothing to indicate its origin and from the brief accounts that I have of the trouble it is impossible to condemn any particular type of soil or any environmental condition as the cause of this disease peculiar to the horse. We have no reports of this disease from the Lower Peninsula. The close comparison between Dr. Deadman's case and other cases coming under his observation, and the disease described by Mohler, Beebe, Franics and Marsteller, and Schoenleber leads us to conclude that we are dealing with Infectious Anaemia in northern Michigan.

The Secretary of the State Live Stock Sanitary Commission requested the Bacteriological Department to investigate an outbreak of an undetermined disease of sheep near White Pigeon, Michigan.

On April, 4, 1909, in the afternoon, I was taken to the farm of Mr. ————, one mile west of White Pigeon by Dr. Conkey of Constantine. Mr. ———— had been losing sheep, breeding ewes, during the last three weeks. Mr. C. A. Tyler had visited the farm without making a diagnosis. He had sent Dr. Haggerty of Coldwater to investigate the trouble and Dr. Haggerty had pronounced it "Neurasthenia." Mr. ———— had lost 14 out of 42 ewes. Dr. Conkey believed that the trouble was due to the fluke, since his observations in a number of postmortem examinations revealed only a badly diseased liver and congestion of the lungs. However, he had found no flukes present.

I found that Mr. ———— had bought these sheep in September, 1908, of a neighbor who had sold them for young sheep—which they were not. They had been kept on dry clover pasture on both farms, according to Mr. ————. They were in poor condition when bought, but gained in flesh and were in very good condition at time of shearing, about four weeks before my visit. They showed a great number of sheep "ticks" (melophogus ovina) when sheared. After shearing, the sheep began to get thin and weak, although they had plenty of corn and oats and a little alsike clover, timothy hay, and shredded corn stalks; no succulent feed had been used all winter.

Ewes were lambing at the time of visit, but very few lambs were saved, and those only by use of cow's milk. One single lamb, only a few hours old, was unable to stand, and its mother was greatly emaciated. All the ewes were extremely thin, some of them seemed hungry, trying to eat corn cobs and picking at refuse in feed manger.

The thinest and weakest ewe was killed by bleeding and examined:

Emaciation extreme; visible mucosae very pale; had given birth to twin lambs the week before, and lost both; os uteri, not yet closed and considerably bloody, mucous discharge in uterus; almost no development of mammary glands; liver, perfectly normal, except for small nodule (Oesoph.-columb) near neck of cholecyst which was filled with normal bile; spleen, kidneys, and pancreas normal; rumen, reticulum and omasum and contents, normal; abomasum, nearly empty; considerable number of stomach worms (Str. contortus) present; small intestines, nearly empty, few minute hemorrhages in mucosa of duodenum; large intestine, normal, contents very dry; very few nodules along intestines; lymph glands, normal; lungs show only one small congested area; heart, normal.

No conclusion can be drawn.

REPORT ON TWO CASES OF SUSPECTED OMPHALO-PHLEBITIS IN LAMBS.

Received from Dr. Fred W. Olley, Caledonia, Mich., two lambs by express, March 25, 1909 a. m.; shipped, March 23, 1909 p. m.

Accompanying letter says: "Appear all right and in about 10 hours are dead. Some of them cough a little, some do not. Owner has lost 12 out of 17 since Sunday, (21st). Ewes are in good condition. Warm stables, but plenty of air and dry. I held post-mortem on two and find in each, one side of lung hepatized and other normal and otherwise everything appears normal except umbilical arteries which are inflamed. Stable is clean and kept so."

Examination of cases received as follows:

Larger female, probably one week old; umbilicus seemed normally healed; digestive tract open; extensive pleurisy with adhesion of right lung to parietal pleura; lungs greatly congested; umbilical vein filled with blood and distended greatly from umbilicus to liver; liver gorged with blood and showed few hemorrhages under capsule. Umbilical arteries prominent, containing some coagulated dark colored blood; serosa of fundus of bladder and broad ligament of bladder between bifurcation of umbilical artery hemorrhagic.

While this investigation is not complete or conclusive as determining the cause of the trouble, the bacteriological and pathological findings indicate umbilical infection.

TRAUMATIC SEROUS INFLAMMATION WITH SEPTICAEMIA.

A case, simulating malignant head catarrh in a shorthorn heifer at St. Johns, Mich., was brought to our attention, June 23, 1909, by Dr. Gohn. This case resembled others that Dr. Gohn had met with in practice and its fatal character, the similarity of the cases and the possibility of an infectious agent being at the seat of the trouble induced us to make an investigation.

We found the case on the farm of Mr. M————. The heifer was perfectly healthy and in excellent condition on the 19th; very sick on the following day, showing high fever, labored breathing, purulent discharge from the eyes and nostrils; no appetite. There were two cases of actinomycosis (?) on the farm at the time. At least, these cases resembled actinomycosis closely, although the ray fungus had not been isolated. We suspected that possibly the same organism might be responsible for the trouble in all three cases. The two cases being treated for actinomycosis were doing nicely.

The subject for our investigation was in very bad condition. The back was arched, eyes discharging and the eye-lids, fly blown; thick nasal discharge clinging to orifices of nostrils; coat, rough; flanks, tucked up; temperature, 104°. The animal was killed by bleeding.

Post mortem: Hard palate and buccal membranes red, showing beginning ulceration; kidneys, congested, abdominal fat, tinged with blood pigment; liver, large, light in color, on section showed bile ducts distended with bile; cholecyst, greatly distended with thick, green viscid bile; adhesions of liver to diaphragm with area of fibrinous exudate and congestion both on liver and diaphragm several inches in diameter; an abscess, the size of a hen's egg, thickly encapsulated, connected the liver, diaphragm and reticulum at this area of congestion; upon opening the reticulum, a bright, new, galvanized carpet tack was found with the point touching the mucosa opposite the abscess; slight congestion of mucosa of small intestines; mesenteric lymph glands reddened in cortex; the diaphragm showed congestion and fibrinous exudate on the thoracic side opposite the abscess and there were adhesions of parietal to visceral pleura at this point; heart showed very extensive sub-endocardial hemorrhage, especially in the left ventricle. There was only a slight congestion of the nasal mucosa and cranial sinuses.

A microscopic examination showed a very short, rod-shaped organism in the pus from the abscess, but nothing in the blood or other tissues of the body. We concluded that the primary lesions was caused by the infected puncture of the reticulum by the tack. This may have taken place some time before the generalized infection or intoxication.

PICKLE INVESTIGATION.

Dr. Otto Rahn of this Department has been interested, in conjunction with Prof. Frank Kedzie, in endeavoring to ascertain the cause underlying a fermentation difficulty encountered by pickling stations. Heavy losses have been sustained by the pickling industry not only in Michigan, but elsewhere. Because of an inability to secure cucumbers, further work has been delayed till August of this year.

SUMMARY OF SOME EXPERIENCES IN THIS LABORATORY.

Some experiences relevant to the determination of the Bacterial Content of Milk.

For the past three or four years, considerable work has been done in the Bacteriological Laboratory of the Michigan Agricultural College, having a direct bearing upon the interpretation of the bacterial content of milk. Last year, special systematic work was inaugurated at the instigation of the "Committee on Standard Methods of Bacterial Milk Analysis," of the American Public Health Association.

Those of our Laboratory who have contributed to this work, are, Mr. Sayer, Mr. Rahn, Miss Farrand, and Miss Northrup, all equally responsible with myself for these experiences.

Our purpose in presenting this paper relates both to the analytical significance and also to the suggestiveness of the work so far as future progress is concerned.

Our work from which these experiences are drawn may be divided into three distinct lines of investigations. (1) "The Associative Studies." (2) "The Keeping Qualities of Butter." (3) "The Systematic Work" conducted for the committee named above.

In the "Associative Studies" it was our privilege to follow the development of micro-organisms in fresh milk through to the point of loppering. From time to time, throughout the period from milking to the loppering of the milk, plates were made of the samples for the purpose of an intimate study of the micro-organisms present at the different stages, and of an estimate of the rapidity of their development. This study, which involved an enormous amount of repetition, revealed to us that the germ content of milk varies with each stage of its development to the time of loppering; accordingly, the micro-organisms present in milk when fresh may not be the same micro-organisms present six hours, twelve hours, or twenty-four hours after milking.

The following table taken from our work on "Bacterial Associations in the Souring of Milk" illustrates this thought.

SAMPLE I.

Hours after milking.	Acidity of sample.	Total number of bacteria.	Relative number of different types.*							
			a.	b.	c.	d.	e.	f.	g.	j.
0	16°	530	12	5	5	6	2	1	0	0
15½	16°	49,500	12	4	1	4	19	0	0	2
20½	16°	275,000	7	7	2	1	2	0	2	2
40⅓	16°	69,000,000	10	0	0	15	3	1	0	36
64⅓	87°	2,000,000,000	0	0	0	3	2	0	0	1,100

* Should be read horizontally only and not vertically.

When zero appears it means that no colonies of that type could be determined, or for some reason were not determined.

Since there was no appearance of any change in this sample, twenty-four hours was allowed to elapse. This was a mistake in judgment, for there ought to have been some record between 40⅓ hours and 64⅓ hours—the milk was loppering at 64⅓ hours.

The time of making the count or studying the species is vitally important, yet it can be readily seen that any particular time determined upon must be open to serious criticism no matter what that time may be. From the practical standpoint, this feature may throw strong evidence against pure milk production, especially in the hands of inexperienced operators.

Again, different samples of milk do not necessarily mean that the germ content at the same hour after milking will be subject to the same conditions of study, for it frequently occurs that one sample of milk will sour at 21°C. from 24 to 36 hours after milking, and another sample will sour from 48 to 72 hours after milking. Should, therefore, a bacterial count at the end of 24 hours be considered the established time for determining the bacterial content, it follows that the interpretation would be wholly erroneous.

SAMPLE I.

Time after milking.	Number of micro-organisms.	Acidity of milk
0 hrs	530	16°
20½ hrs	49,500	16°
28 1-6 hrs	275,000	16°
40⅓ hrs	69,000,000	16°
60⅓ hrs	2,000,000,000	87°

SAMPLE II.

0 hrs	1,380	16°
15 hrs	720,000	17°
21 hrs	7,670,000	23°
42½ hrs	423,000,000	55°
69 hrs	1,600,000,000	69°

SAMPLE III.

0 hrs.	221,000	17°
7 hrs	1,780,000	19°
23 hrs	3,800,000	19°
32 hrs	204,000,000	19°
47 hrs	1,633,000,000	43°
53 hrs	1,936,000,000	63°
71 hrs	853,000,000	72°

SAMPLE IV.

0 hrs	22,000	15°
8½ hrs	58,000	15°
24 hrs	988,000	15°
32 hrs	2,090,000	15°
48 hrs	24,000,000	14°
56 hrs	478,000,000	16°
72 hrs	789,000,000	20°
80 hrs	914,000,000	34°
96 hrs	960,000,000	63°
104 hrs	2,000,000,000	77°

I submit the above tables to illustrate the fact that the number of micro-organisms at the end of 24 hours is not necessarily a guide to the number on the start or that, if the established time for counting were at the end of twenty-four hours, would the results of the count by determination of species be a necessarily true index of the germ content.

Still again, another point that was very forcibly illustrated in connection with these studies, was the difficulty in securing satisfactory and logical counts of some species of micro-organisms. Making every effort to have these counts result in logical sequence from their respective dilutions, it was found that it was practically impossible to succeed. This, of course, was found only with certain micro-organisms; other micro-organisms seemed to lend themselves freely to dilution with excellent results.

We attributed these experiments to one of these causes:

1. Tenacious grouping of micro-organisms in which the adhesive walls barred detachment of single cells.
2. Overcrowded plates manifest associative influences which may be antagonistic or favorable.

In this connection I wish to speak of still another interesting matter connected with our "Associative Studies" which at the time the work was conducted appeared very significant, but the conclusion was reversed in the butter studies a little later. We found that whey agar gave better conditions for growth of lactic acid bacteria than an ordinary agar. Although it was not universally true so noticeable was it at times, that development of lactic acid types seemed to depend entirely upon the nutrient conditions furnished by the whey agar.

In the butter studies as conducted by Mr. Sayer, Mr. Rahn, and Miss Farrand, it was found that the lactic acid micro-organisms grow well on ordinary, lactose, and whey agar, while those micro-organisms associated with the lactic prefer the ordinary agar. However, the results are not especially marked in either case. In both instances, Miss Farrand was immediately responsible for the work.

Another observation was made while conducting the butter studies. Miss Farrand, who did much of the bacteriological work in connection with the butter studies, and practically did all the counting, did some of the work in connection with the studies in association. It is singular to note that she succeeded in securing more logical counts in butter than in milk. The question may be asked: Was there less opportunity for cells to group or adhere in butter than in milk, or taking a step forward, was agglutination possibly a factor in milk and not in butter?

The systematic work conducted by Miss Northrup for the committee has some of the same features to deal with as have been considered under the foregoing heads. Her work consisted largely of studying the influence of agar of different compositions upon the determination of the germ content at two temperatures, 21°C. and 37½°C. Acidity, lactose and peptone were the ingredients subject to variation. A summary of her results are conveyed in the following table.

FINAL SUMMARY OF TEMPERATURE.

Percent of samples growing best at	21°C.	63%
Percent of samples growing best at	37°C.	9%
Indeterminate		28%

FINAL SUMMARY OF ACIDITY, LACTOSE AND PEPTONE MEDIA.

		Temperature.	
		21°C.	37°C.
Acidity	5°	5%	13 %
	10°	21%	17 %
	15°	64%	33 %
	20°	10%	17 %
Per cent of lactose	0%	15%	20 %
	1%	27%	10 %
	2%	22%	17½%
	3%	15%	17½%
	4%	21%	35 %
Per cent of Peptone—First lot	0%	22%	27 %
	1%	6%	6⅔%
	3%	72%	66⅔%
Per cent of peptone—Second lot	0%	35%	35 %
	1%	38%	23 %
	3%	27%	42 %

The comments I wish to make upon the detailed work of Miss Northrup are these:

1. The multitude of counts made by her is massive but open to analytical criticism. They are irregular and seemingly illogical. Since we have discussed this matter previously, we shall pass it over without further remarks.

2. When she has added different percentages of lactose and peptone to her agar medium, her average results are inconclusive, and also lack logical sequence.

3. In the case of temperature the larger percentage is in favor of 20°C; in the study of the most suitable acidity, 15° acid represents the most favorable amount in percentage. However, these averages must be subject to more or less fluctuation.

In general, in statistical evidence of this nature, the highest percentage does not represent the most desirable method of testing, but rather the lamentable weakness of our present system. The statistical methods of obtaining laboratory results is reprehensible unless all conditions and agents are the same; vary these conditions and agents, they will lose their force. The averages which have been cited are misleading because of their dissimilarity, hence are at best crudely approximate.

RECAPITULATION.

We may assume from our observation that:

1. Milks vary in their bacterial content both as to
    a. Numbers.
    b. Species.

2. This variation is dependent upon the
    a. Source of milk.
    b. Method of milking.
    c. Cleanliness in handling.
    d. Temperature maintained.
    e. et cetera.

3. Milks in the light of the above develop their germ content.
    a. With the same rapidity or
    b. In the same relative manner

and therefore cannot respond *alike* to even ideal and perfect methods of testing.

4. Methods of testing are only incidental to the real problem. They should be employed to indicate and assist in control.

5. While composition of media, means of dilution, the time of plating, temperature for plate development, and other factors are highly important in the execution of these tests, the most essential factor *at this time* is uniformity of methods that the variable minor discordant elements may to a large extent counteract each other through the accumulation of evidence.

6. It follows that the purpose of the "Committee on Standard Methods of Bacterial Milk Analysis" is justified, even though many of its detailed decisions are arbitrary and perhaps unwarranted should uniformity of methods be established.

7. However, much would be sacrificed, if laboratory men forget the real purport of such analysis and use them simply to estimate the milk per se instead of the conditions which are indicated by such analysis.

In closing, I desire to suggest that perhaps we shall make more rapid progress and secure more enduring results, were we to devote our energies to more exhaustive elemental studies which will assist us in the solution of some of these problems.

Respectfully submitted,
CHARLES E. MARSHALL,
Bacteriologist.

East Lansing, Mich., June 30, 1909.

REPORT OF THE HORTICULTURIST.

To the Director:

Sir—I herewith submit a brief report for the year ending June 30, 1909.

A bulletin entitled "Can the General Farmer Afford to Grow Apples, and the Suggestions on Improving and Spraying Apple Orchards" by S. B. Hartman and H. J. Eustace was issued in the early spring. There are many apple orchards in the state that should give good returns if properly cared for, and there was a large demand for information along this line. Mr. Hartman, a graduate of the college and a successful fruit grower and farmer, had for several years been caring for orchards in his neighborhood, and had correct accounts of the expenses and returns. He was induced to put this data into bulletin form, and to this was added such general information as would be useful to a farmer in caring for his orchard.

A circular giving directions for treating seed potatoes for scab was sent to all the newspapers of the state early in the spring.

Experiments are now under way with potato fertilizers; on potato spraying; fruit tree and grape vine fertilizers; orchard spraying; apple propagation; bud selection to secure hardiness and disease immunity in the peach; the value of sterilizing greenhouse soils; and a comparison of the methods of storing nursery stock.

Many of these experiments are being conducted in sections of the state where they will be of the most interest and value to the community and have a direct bearing upon the local industry.

Further experiments will be started as rapidly as is consistent with careful work, and such problems as are of the most economic importance to the horticultural interests of the state will have first attention.

It is a matter of serious regret that after 20 years of the station's existence there was no horticultural work under way, that all the experiments had to be started recently, and that the past publications are of such a nature as to be of very little value at the present time. There is a demand for general information regarding the horticultural crops of the state, and a series of bulletins to meet the need will be prepared as soon as possible.

I take pleasure in acknowledging my appreciation of the services of Mr. C. P. Halligan, assistant horticulturist, and to you for loyal support and encouragement in our efforts to bring up the horticultural work of the station.

Respectfully submitted,
H. J. EUSTACE,
Horticulturist.

East Lansing, Mich., June 30, 1909.

REPORT OF CONSULTING HORTICULTURIST.

R. S. Shaw, Director:

Sir—During the past year my work in the Experiment Station has included the general oversight of the fruit-testing sub-station at South Haven, a considerable amount of cooperative experimental work, particularly in the relation of fruit culture, and an extended correspondence in replying to letters of inquiry that have been addressed directly to me or that have been referred either by yourself or other officers of the station.

THE SOUTH HAVEN STATION.

Mr. Frank A. Wilken has continued in immediate charge of the station. The work outlined in my report of last year has been in progress and the results obtained during the season of 1908 were reported in the special bulletin which was distributed in the spring.

The original plan of the station was that it should be used for the testing of such new fruits as were brought to the notice of the public and, at the same time, for growing the standard varieties in order that the comparative value of the new sorts might be ascertained. Although the tract occupied by the station is supposed to contain fifteen acres, two streets have been opened through it and a large amount of the land is also occupied by buildings, lawns, drives and by the hedges which surround the two blocks, so that but little more than ten acres is actually available for experimental work. When the station was established, practically all of the land was planted with trees and bush fruits using two trees of each variety and from six to twelve of the bush fruits to be used for variety testing. The trees were planted sixteen feet each way with the idea of removing them as they grew and began to crowd each other. This has been done with most of the apple trees and with some of the older plantations of cherries and pears. The peach trees that were first planted reached maturity some years since and were removed. Trees of other new varieties were secured, as opportunity occurred, and were planted upon land on which bush fruits had been growing while new plantations of the different bush fruits were made where one block of the peach trees was taken out.

On account of the close planting and particularly because of the fact that there are now only one or two trees of a variety, it has not been possible to carry on any very definite plot experiments either with fertilizers or insecticides and fungicides, and the conditions are far from favorable for experiments with orchard cultural methods. While the location of the station is, on many accounts, very favorable and it should be continued on its present site for a number of years, the writer has for some time been of the opinion that in order to do the best work additional land is necessary. Although there is none available adjacent to or in the close vicinity of the station it will be an easy matter to find a suitable tract which should contain at least forty acres within two or three miles of the present station, which could be used not only as a model and demonstration fruit farm, but upon which plantings could be made that would be available for extended and careful experiments in cultural methods, with fertilizers, and with insecticides and fungicides.

The five acres of land now owned by the station has greatly enhanced in value during the last ten years and the ten acres adjacent upon which the station buildings are located, and which is the property of the State Horticultural Society, has a value perhaps three times as great. If arrangements could be made with the State Horticultural Society by which all of the land could be sold and the proceeds invested in a farm of forty to sixty acres upon which experiments in fruit growing could be conducted by the station along lines mutually agreed upon by the station and society, I am sure that a very small increase over the present annual expenditure for the maintenance of the station would make it possible to secure far more valuable results than with the present location.

Especially if a farm, a part of which is planted to an orchard that is now in bearing, is obtained, the returns would help materially in defraying the cost of maintenance. I trust that this plan may have careful consideration.

THE WORK OF THE YEAR.

A large number of new varieties of all kinds of fruits bore their first crops last year and notes were also obtained upon many other varieties of recent introduction whose value has not been determined. There are, however, at least one hundred and fifty varieties of tree fruits that have not borne and a much larger number which should have considerably more attention in order to ascertain their merits. Full descriptions of the new sorts were given in the report.

Spraying. Owing to the great increase in the interest taken by fruit growers in matters relating to the spraying of fruit trees, even more attention than in previous years has been given to experiments with insecticides and fungicides. By using some of the standard formulas as a check, it was possible to carry on part of this work upon the station trees but, for a considerable portion, and particularly for the testing of remedies for the San Jose scale, it was necessary to make use of orchards in the vicinity.

During the season comparative tests were made of the various brands of insecticides and fungicides now upon the market and of the homemade mixtures that are used for the same purposes. The commercial brands of miscible oils and lime-sulphur solutions were used to determine not only their value against the San Jose scale but as remedies against fungous diseases. While for some purposes the lime-sulphur solutions when diluted and used as summer sprays gave fairly satisfactory results, we are not prepared as yet to recommend their use in the place of Bordeaux mixture, except perhaps for a few special purposes and upon varieties which are seriously injured when the latter spray is employed.

The tests of arsenate of lead, as a substitute for Paris green and the other arsenicals which have been used in the past, were very satisfactory and, considering the fact that per unit of arsenic oxide it costs no more than Paris green, its adhesive qualities make it far more valuable as while a dashing rain might wash the last trace of Paris green from the foliage, it will have very little effect upon the spray of arsenate of lead which has had time to dry on. The fact that arsenate of lead when properly made can be used at considerable strength upon even the most tender foliage, which would be seriously injured when sprayed with Paris green at greatly reduced strengths, makes it a much safer remedy than Paris green or, in fact, any of the other arsenicals. The reports that have been made from time to time by the station, upon the results obtained with arsenate of lead as a substitute for Paris green upon potatoes as well as fruit trees, have led to its coming into quite general use for spraying purposes and, during the present year, tons will be required to supply the demand where pounds answered a few years ago.

For a number of years the manufacturers were not able to furnish it in a form which could be readily mixed with water but they have now so changed and improved their formulas that it is little if any more work to prepare it than is required with Paris green.

The results obtained with the lime-sulphur mixtures were not different from those secured in previous years. Where the applications were thoroughly made nearly as good results were secured with the commercial mixtures as with the home-made of the usual strength, although the former did not seem as lasting in its effects, when used against the San Jose scale. The price, of course, is considerably higher than that of the home-made mixture but, when a small quantity only is desired and especially if one does not have a kettle or outfit for cooking it, many will prefer to purchase it already prepared. When a large amount of spraying is to be done, at the present price of sulphur which is about two dollars per one hundred pounds, the cost of making fifty gallons, using the regular formula of fifteen pounds of sulphur and the same amount of lime in fifty gallons, will be but little more than three-fourths of a cent per gallon for material; while at the lowest price quoted, the commercial brands cannot be purchased for less than one and one-half cents per gallon, diluted to contain the same amount of sulphur as in the home-made mixture, so that the economy of the latter can be readily seen.

Many have objected to the use of the home-made mixtures because when prepared after the usual formula they must be used at once and many persons have trouble with their use through the clogging of the nozzles. After considerable experimenting, Mr. Wilken was able to make a concentrated solution which closely resembled the commercial brands and, as it had no sediment, it was equally free from objections on account of clogging and could be kept as well, or even better, than the more highly concentrated, commercial solutions. As was explained in the report of the station, it contained only one-half the quantity of lime used in the regular formula and, by a little extra boiling, could be so concentrated that there would be 120 pounds of sulphur in fifty gallons of the solution.

Considerable attention was also given to the use of calcium bromide and calcium sulphide as summer sprays for the control of the scab and other fungous diseases of fruit trees but further experiments are desired before positive conclusions can be reached.

Cultural Experiments at South Haven. Next to spraying and the use of fertilizers there is perhaps no question that is more often asked by the fruit grower than the proper care of orchard trees. The conditions of soil and climate have so much to do with the growth of trees that no single experiment can determine what method will give the best result under all conditions; but, as it will have a more or less general application in a large portion of the "Fruit Belt," an endeavor has been made upon the station grounds to secure some light regarding the best way to grow apples, pears peaches and plums in sections where the soil is a sandy loam with a clay subsoil. The method of treatment was described in the report of last year and, at the end of two seasons, it can only be reported that the heavily mulched trees have made a growth fully equal to those cultivated, but it should be stated that the land had been in cultivation up to the time the trees were planted and the result might have been quite different had the trees been set in a heavy sod.

In caring for the mulched plots particular attention was paid to using sufficient straw not only to prevent the grass from growing under the trees but the covering extended a foot or more beyond the ends of the branches in all directions in order to conserve the moisture even outside of the feeding area of the roots. Failure to do this, in many instances where orchards have been mulched, has led to partial or complete failure of the trees and few persons seem to comprehend that it is necessary to use a thick mulch, and that a narrow ring of mulch around the trunks will not suffice.

FRUIT EXHIBITS AT FAIRS.

Although the fruit crop upon the station trees in 1908 was not as heavy as in some years, very creditable exhibits were prepared by Mr. Wilken and were shown at the State Fair at Detroit and at the West Michigan Fair at Grand Rapids. The collections of apples and pears were very large and of high quality but owing to the killing back of the grape vines by the freeze of 1906, only a few varieties of that fruit could be shown. For the same reason, no peaches were exhibited, all of the trees having been killed and those planted since that time being too young to bear.

COOPERATIVE EXPERIMENTS.

The experiments carried on in cooperation with fruit growers referred to in my report of last year have been continued. Considerable progress has been made in various parts of the state in the spraying experiments and the results secured where tests of fertilizers and trials of various orchard cultural methods are being made have been very helpful not only to the writer but to the parties cooperating and, in many cases, to their neighbors who are noting the results.

Cooperative Spraying. In many cases the experiments have been very largely for demonstration purposes and the methods used have been those worked out in previous years either at South Haven or at other points in the state. They have been carried on for the most part for the purpose of showing what can be done in the way of controlling our more troublesome insect pests and fungous diseases, when the directions which have many times been given in bulletins and spraying calendars are carefully followed. The results have been very satisfactory as, where the work has been properly done, the benefits have been very marked. Not only have the participants become firmly convinced of the necessity of and the profits from spraying, but they have become its earnest advocates, and spraying centers have thus become established which cannot fail to have a markedly favorable influence upon the development of the fruit interests of the locality.

Without going into details, it can be said that the information that has thus been disseminated regarding the control of such troublesome insects as the San Jose scale, codling moth, plum curculio, grape berry-moth, rose-chafer and destructive fungous diseases like the apple-scab, brown-rot, the various leaf-blights, peach leaf-curl and the black-rot and mildews of the grape, together with the fact that the leading growers in the fruit belt have not only been very quick to avail themselves of it but have been very thorough in their work of spraying, has resulted in saving hundreds of thousands of dollars.

As one instance of this work the cooperative experiments in the Lawton grape district may be mentioned. My attention was first called to the serious losses in that section from the black-rot in 1905, and arrangements were at once made to demonstrate that, with proper attention in the way of spraying, the loss could be so restricted as to be hardly noticeable. My own experience with this disease in Missouri before coming to Michigan, and the results obtained during the last twenty years in the experiments carried on by the U. S. Department of Agriculture and the experiment stations in several states, satisfied me that there would be no difficulty in controlling the disease if owners of vineyards in which the disease appeared could be impressed, first, with the danger which threatened their crops unless steps were taken to control it; second, with the fact that they could find in Bordeaux mixture a cheap, safe and effectual remedy; and third, with the importance of not only spraying their vines at the proper intervals but of doing the work so thoroughly as to cover every fruit and leaf with the spraying material.

At first many of the growers were quite skeptical, claiming that they had had no trouble from the disease for fifteen years or more and that, although the climatic conditions might be such as would favor the development of black-rot for a single season, the weather during the period when the rot prevails was almost always hot and dry, a condition very unfavorable for its development and hence the chances were so strongly against the disease proving injurious in other years, that it would not pay them to go to the expense of procuring spraying outfits and spraying their vineyards.

Others scoffed at the very idea of its being the dreaded black-rot, or, if it was, that it could be controlled by spraying. There being no question as to the nature of the disease, or to the proper treatment, it was thought best not to run any risk but to at once undertake cooperative demonstration work. Mr. F. E. Morrill, of Paw Paw, and Mr. D. L. Thornton, of Lawton, agreeing to undertake the work under my direction, a series of experiments were planned for each. They were asked to set aside portions of their vineyards which were to be divided into six plots which were to receive from two to six applications each. The weather during a considerable portion of June and July was wet and muggy which, on the one hand; made spraying difficult and lessened its effects, while on the other it favored the development of the black-rot.

Owing to the fact that in each case the spraying was omitted at a critical time and probably also because they were not sufficiently impressed with the importance of thorough work, the results in both vineyards were less satisfactory than had been hoped for. While the loss of grapes was quite serious, the experiment served to impress upon the owners as well as their neighbors, who were carefully watching the results, the fact that in order to be effectual against this disease, it was highly essential to keep the vines covered with a fungicide from the time the growth appeared until the crop was gathered.

In 1907 and 1908, similar experiments were also carried on by Fred J. Diehl, of Paw Paw, and by Frank and Charles Stainton, of Lawton, all of whom had sprayed in 1906 and hence were able to do good work. The results obtained by them, as well as by Messrs. Thornton and Morrill in those years, were quite satisfactory as although in 1907 in particular, the conditions were so favorable to the disease that upon unsprayed vineyards the crop in many instances was entirely destroyed, the actual loss from black-rot in any of the vineyards in which the cooperative experiments were carried on was hardly worth considering.

The weather in June, 1908, was also conducive to the development of black-rot and it threatened to do serious harm upon vines that had not been sprayed, but a severe drouth prevailed in July and August so that in most vineyards the loss was comparatively slight, ranging from fifteen to fifty per cent of the crop, except in a few instances where the vines were neglected in which cases the crop was not worth gathering, from seventy to ninety per cent of the grapes being attacked by black-rot.

As all the experimenters had become more expert in their spraying operations and impressed with the need of regular and thorough work, they were able to almost entirely control the disease so that the loss was little, if any, more than one-tenth of one per cent, or certainly not more than twenty-five cents per acre as compared with a direct loss of from fifteen to twenty-five dollars per acre where the vines were unsprayed. In estimating the loss resulting from black-rot, the extra expense in packing grapes owing to the necessity for trimming the diseased clusters, should not be overlooked as this in many cases will fully equal the entire expense of spraying the vineyard for the season, to say nothing of the deterioration in the value of the fruit, owing to the mutilated clusters and the injury to its appearance from the extra handling.

The cost of spraying varies of course with the strength of the Bordeaux mixtures used, as well as with the number of applications, the size of the vines, and the thoroughness with which the work is done. Particularly in the case of when the rot is very troublesome, experiments show that it is penny wise and pound foolish to attempt to economize either in the amount of material used, or in the time taken for making the applications, until one has made sure that the vines are thoroughly sprayed.

For the spraying of vineyards it was found advisable to use Bordeaux mixture containing for the earlier applications four pounds of copper sulphate and four pounds of stone lime in fifty gallons of water, but after the first of July the amount of each can be reduced to three pounds and, if it becomes necessary to spray after July 15, two pounds of copper sulphate and one pound of lime will be sufficient for fifty gallons. By reducing the amount of lime for the later applications, there will be no danger whatever of spotting the fruit and it will be found more effectual and far less expensive than the ammonia solution of copper carbonate, or the Burgundy mixture which was formerly used.

The amount required for spraying an acre of grapes will depend upon the age and strength of the vines as well as upon the date of the application. For the average vineyard of bearing age, fifty gallons per acre will suffice during the early part of the season but, while many restrict themselves to the use of this quantity, it will be found better to increase the quantity where the vines are large and the growth is thick and in all cases sixty to eighty gallons can be used to advantage for spraying an acre of grapes after the fruit has set. Arrangements should be made to carry a high pressure and, when traction outfits are used, it should be so gauged as to produce a fine spray even when the team is moving very slowly. In this way only will it be possible to do thorough and effectual work.

Particularly if the growth is very thick, and the conditions are favorable for rot, it will often pay after the grapes are half grown, in addition to using the stationary nozzles, to have two men follow the rig with "trailers," or lines of hose with one or more nozzles, at the ends of short extension rods, with which they make sure that every grape is coated with the spraying mixture.

While no definite rule can be given for the number of applications that should be made under all conditions, results show that at least two applications will be well repaid from the benefit that will result against the grape mildews, even though no rot appears and, in seasons when the latter disease is troublesome, from five to seven sprayings can be given with profit. At the very least, one treatment should be given before the blossoms have opened and a second when the fruit is of the size of small peas. In vineyards where the rot has been troublesome the previous year the number of applications should certainly be increased. The first spraying then should be given when the new growth is twelve to fifteen inches long and another just before the blossoms open. The use of a treatment with copper sulphate solution (two pounds in fifty gallons of water) in the early spring, also seems to be very helpful in vineyards where rot has prevailed.

After the fruit has set, the spraying should be continued if the weather seems favorable for it, or if it is proving injurious in unsprayed vineyards. The treatment is necessarily preventive in its nature and spraying will be of no value to a grape after it has been attacked, hence the only safe way is to make sure that the fruit and leaves are kept coated. The disease is spread by means of spores which develop only in minute drops of water and, as it generally takes twelve to fourteen days from the time one crop of spores has developed until the next appears, it will suffice if the vineyard is sprayed within ten days after a rain or period of muggy weather. Ordinarily then from two to four applications after the fruit has set will be sufficient although, if rains are frequent and wet, warm weather continues into August, one or two other treatments, using the reduced formula with the minimum amount of lime will be of value.

Depending upon the convenience with which water and the other spraying materials can be obtained and the difficulties that may be met with in preparing the mixture and making the application, from five to ten acres may be sprayed in a day and the work done very thoroughly. The following estimate for the cost of spraying an acre of vineyard with five applications of Bordeaux mixture is an average for medium-sized vines:

Labor, man and team, 6 hrs. @ 40 cents..........	$2 40
32 lbs. copper sulphate, @ 5 cents...............	1 60
30 lbs. lime @ ½ cent..........................	15
Extra labor on trailers, and in preparing mixture, 5 hrs. @ 15 cents............................	75
Total............................	$4 90

In the above, no account is taken of the cost and depreciation of the spraying rig, or of water-works and other conveniences required for making the mixture. The cost would also be somewhat increased if it became necessary to haul the water any distance, or if any serious breakdown or delay occurred in the work. On the other hand, when only two or three applications are made, as might be sufficient in many cases, the expense would be correspondingly lessened.

In addition to the injury done by black-rot, serious losses also result from the attack of downy mildew and anthracnose, while powdery mildew is often quite injurious in hot, dry summers to varieties that are in part of European origin. Aside from the loss which results from the injury of these diseases to the fruit, even greater harm is done by them to the foliage as it is not uncommon to see vines growing with a full crop of fruit, which they are not able to ripen owing to the loss of their leaves from the attack of mildew. This can be entirely prevented by giving the first two or three applications recommended for the black-rot.

While the black-rot has not been generally troublesome except in the Lawton district, it has made its appearance in quite a number of vineyards in other sections and has caused serious losses in various parts of the state. For this reason, although we cannot recommend every one to give his grapes the full number of applications suggested for the black-rot, every grape grower who has noticed it upon his vines should be prepared to spray and from the fact that there are very few vineyards where mildew and destructive insects are not doing some harm, it is the opinion of the writer that it will be only in exceptional cases where at least two applications cannot be made with profit.

For a number of years the use of dust sprays for the prevention of diseases of the grape and other fruits has been strongly advocated by manufacturers of dust spraying machinery. In 1907 and 1908 this was given a thorough trial by several of the growers at Lawton and Paw Paw but although it would have undoubtedly aided in controlling the powdery mildew it seemed to have little effect on downy mildew or black-rot, as the injury from these diseases was practically as great as upon neighboring, unsprayed vineyards. At a conservative estimate, fully twenty-five per cent of the crop was destroyed by black-rot alone where the dust spray was used, while with a smaller number of applications with liquid spray it was reduced to a small fraction of one per cent.

Similar claims have also been made for lime-sulphur solutions as summer sprays but, although a thorough trial was made, little if any benefit could be detected while, even when used at the strength of one to fifty, the commercial brands caused considerable injury to the foliage and even though the leaves were not actually burned, they seemed to be of a smaller size and less healthy in appearance than those on unsprayed vines; on the other hand, where Bordeaux mixture was used, the leaves were large, and possessed a dark green, healthy appearance that was not found on unsprayed grapes.

In some years considerable injury has been done by the rose-chafer, grape berry-moth and the steel-beetle. The rose-chafer, or rose bug as it is commonly called, often appears in immense numbers when the grapes are in blossom and by feeding upon the flowers and young fruit may seriously injure the crop, in some cases entirely destroying it. Attempts have been made to control them by collecting in pans in kerosene but this proves very expensive and is not feasible where one has a large area of grapes. Spraying the vines also was tried but, when Paris green was used in water or Bordeaux mixture, although it may have killed many of the beetles, it did not suffice to save the crop as, before eating enough of the poison to be fatal, a large number of blossoms would be destroyed. It was observed, however, that the beetles were very fond of sweetened water, and experiments during the last two or three years have shown that, by using three to five pounds of arsenate of lead in fifty gallons of water, to which a quart of cheap molasses had been added, it would destroy the beetles and they would be prevented from causing serious injury to the grapes as, if the application was made when they appeared in numbers, the rose-chafers would leave the flowers and feed upon the poisoned water.

The grape berry-moth caused considerable injury in 1907, but a large number of growers found that they could control the insect by spraying with arsenate of lead just before the blossoms opened and again when the fruit had set. As these applications can be made in connection with the use of Bordeaux mixture for the control of the black-rot, the only extra expense will be the cost of the arsenate of lead, and, as two pounds will suffice for fifty gallons, it will not be more than fifty cents per acre for the two applications.

The steel-beetle sometimes appears in large numbers as the buds are swelling and by eating out the center of the buds prevents the growth of new shoots. After the leaves have developed, the larvae appear and feed on the green tissues. If the perfect insects are present in large numbers it will be well to spray the dormant vines with arsenate of lead adding perhaps an equal amount (two pounds) of copper sulphate as a fungicide. The regular sprayings with arsenate of lead will prevent any injury by the larvae and, in fact, if this has attention there are not likely to be many beetles the following spring.

I am glad to be able to report that, as a direct result of the cooperative experiments carried on at Lawton and Paw Paw, there has been a very marked increase in the amount of spraying done and in the general interest taken in the grape crop. In 1908, fully two hundred power outfits were used in the Lawton district and in most cases the work was very thoroughly done. Had there been an equal amount of spraying in 1906 and 1907, the increase in the value of the grape crop that would have resulted would have amounted to several hundred thousand dollars.

COOPERATIVE FERTILIZER EXPERIMENTS.

A large number of tests of fertilizers upon several of the leading fruit crops have also been made. The results have been particularly noticeable where the experiments have been carried on in vineyards. This may have been in part due to the fact that grapes are very largely grown upon sandy loam soils, which are somewhat lacking in fertility, and after a number of crops have been secured, the vines are not able to make the required growth and the bunches will be small in both numbers and size unless plant food is supplied and, in most vineyards, this has been neglected.

The experiments included the use of various combinations of nitrate of soda, muriate and sulphate of potash, and ground bone or acid phosphate, in amounts of from 300 to 500 pounds per acre. It was found that the older vineyards upon light soil gave best results when supplied with fertilizers containing the three elements, nitrogen, phosphoric acid and potash. A mixture of 50 pounds of nitrate of soda, 100 pounds of muriate of potash and 300 pounds of acid phosphate produced a very noticeable gain in the growth of vines and upon the number and size of the clusters as well as of the berries themselves. Where the soil contains a fair amount of humus, part or all of the nitrate of soda may be omitted, and upon the clay loam soils the potash may be reduced, or left out entirely, as acid phosphate or ground bone used alone gave nearly, if not quite, as good results as when potash was added, while the addition of nitrate of soda tended to increase the growth of the vines and, besides lessening the crop, resulted in an increase in the amount of rot.

The use of potash in a fertilizer, particularly upon sandy soils, results in a very noticeable improvement in the flavor of the grapes and when one wishes to grow strictly high-class fruit it is advisable to use the sulphate rather than the muriate of potash.

Other experiments with the use of fertilizers upon apple and peach orchards and strawberry plantations are also under way. Although the results have been less noticeable than with the grape, the experiments have been carried far enough to indicate that where the soil is fairly well supplied with humus, excellent results can be obtained from the use of potash salts and ground bone or acid phosphate in the amounts recommended for vineyards.

DEMONSTRATION MEETINGS.

During the year, in addition to speaking at a dozen or more farmers' institutes upon horticultural topics, I have conducted a number of demonstration, or, (as it was not often possible to give actual demonstrations) it might be better to call them inspiration meetings, where topics relating to the use of up-to-date methods in fruit growing were discussed.

'Three of these meetings were held in Van Buren county and one each in Allegan, Newaygo, Mason and Barry counties. In every case it has been reported to me that as a consequence of the meetings, the farmers are giving more attention to their orchards and vineyards in the way of spraying, cultivating and the use of fertilizers.

I have also attended the annual and winter meetings of the Michigan

State Horticultural Society, and taken part in the program. I was also invited to speak at the annual meeting of the Illinois State Horticultural Society held at Champaign, and to lecture to the students in the short course in horticulture at the Illinois State University. In February, I gave two addresses upon horticultural topics at South Bend before the St. Joseph County Farmers' Institute, and a month later responded to an invitation to give three addresses at the Menominee County Agricultural School in connection with the Farmers' Short Course.

I have also acted as superintendent of the Horticultural Department of the State Fair and have had the general oversight of the landscape features of the fair grounds. At the Grand Rapids Fair I looked after the installation of the South Haven Station Exhibit and was in charge for a portion of the week.

CORRESPONDENCE.

A considerable portion of the time has been required to answer letters of inquiry upon horticultural matters. Many of them are from parties in other states who contemplate moving to Michigan to engage in farming or fruit growing, and write to ask regarding desirable locations or the adaptability of a given section to their particular purpose. In other cases, they are from city-bred men who have already moved here and are seeking information as to the best methods of handling their land or crops. Many of the writers confess they have had no experience and know nothing about farming, but are anxious to obtain definite information.

It is often possible to send them bulletins that will be helpful and, upon subjects which seem to be most often asked about, I have prepared circulars which are mimeographed and kept on hand to use when opportunity occurs.

I have also continued the plan of sending short articles, generally 600 to 800 words, upon horticultural subjects to the county papers, so that during the spring and summer months they will have one nearly every week. They are upon timely subjects and are sent to the sections of the state where they are likely to be of most interest. They have been quite generally used and I have received many letters from the editors of the state commending the plan, and asking that they may be furnished with the articles regularly.

In closing, I wish to express my hearty appreciation of the work done by my assistant, Mr. Frank A. Wilken, as superintendent of the South Haven sub-station, and to commend his earnest and painstaking efforts, as well as the interest, fidelity and excellent judgment he has shown.

L. R. TAFT,
Consulting Horticulturist.

East Lansing, Michigan, June 17, 1909.

REPORT OF THE CHEMIST.

Director Shaw:

Sir—I have the honor to submit the following report of the work of the Chemical Division for the year ending June 30, 1909.

ANALYTICAL WORK.

During the past year the following samples have been received and analyzed:

Official fertilizer samples	214
Farm and other departments	163
Experimental	54
Miscellaneous	93
Total	524

FERTILIZER CONTROL.

The number of licensed fertilizers is increasing each year, the increase this season over last year being more than thirty brands. Mr. Grover J. Secord has been secured as a temporary assistant during the fertilizer season and his work has been very satisfactory. The cost of collecting the samples is also increasing as the use of commercial fertilizers is becoming more widely distributed. Mr. A. M. Irish, of Lansing, Michigan collected nearly all of the samples this season and we feel greatly indebted to him for his faithfulness in the performance of the work.

HATCH FUND.

Owing to the extended dry weather that prevailed over the entire southern portion of the state last fall, the fertilizer experiment conducted on the Howarden Farm, at Edwardsburg, suffered considerably, and the spring seeding of clover and fall wheat were both killed during the winter. It was, therefore necessary to change the plan of the experiment somewhat for this season.

The results of last year's work were very convincing and showed the unmistakable value of lime on that soil, especially for clover.

In response to the urgent request of a number of cattle breeders throughout the state, a number of samples of abortion cure, breeding tonic, et cetera, have been examined and the results will soon be presented for publication.

In conjunction with the Horticultural Division an experiment has been initiated to determine the influence of commercial fertilizers upon the growth of young fruit trees and grape vines. The experiment as planned will extend over several years.

ADAMS FUND.

The projects under the Adams fund have been confined to a study of the nitrogenous compounds in soils and of the chemical factors rendering soluble the insoluble phosphates of the soil.

Dr. Jodidi has given his entire time to the first project and a preliminary report is now ready for publication.

What time the writer has been able to devote to research work has been given to the second project, but nothing is ready for publication.

It is with regret that I record the resignation of Dr. Jodidi, as research chemist, to take effect July first, he having accepted a more remunerative position with the experiment station at Ames, Iowa. Dr. Jodidi has been connected with this station since February 1, 1908. His work has been characterized by a high degree of intelligence and all of his ambitions have been wrapped up in it. His love for research work has made him a valuable man for the institution. His successor has not yet been decided upon.

In closing this report I wish to express my gratification to my associates who have faithfully performed the duties devolving upon them.

Very respectfully yours,
ANDREW J. PATTEN,
Chemist.

East Lansing, Michigan, June 30, 1909.

REPORT OF THE ENTOMOLOGIST.

Director R. S. Shaw:

Following is a brief report of the work of the Division of Entomology for the year ending June 30th, 1909.

The year has been notable for the absence of serious insect ravages. Grasshoppers did some damage in the North, and the gooseberry fruitworm has caused some loss both here and at South Haven. The cigar case-bearer has appeared in serious numbers in the eastern part of the state but further than this, the insect ravages have been little more than the usual trouble with scales, rose-chafers, wire worms, and other common pests.

Short trips have been made to several places and addresses given on shade tree pests, fruit pests, and the like, beside several to investigate false alarms concerning the gypsy-moth and brown-tail. These creatures are of such a serious nature that one hesitates to neglect any possible chance of the appearance of such serious menace in the state. A trip to the American Association of Economic Entomologists was made by the writer and by Dr. Shafer. At this time it was possible to attend also meetings of the Entomological Society of America and those of the Washington Entomological Society, beside the regular meetings of the American Association for the Advancement of Science. The facts gleaned from these meetings have been of great value. The writer also went to the Upper Peninsula for further investigation of the tamarack saw-fly and its diseases. This scourge is steadily destroying the tamaracks in the North and is working injury even as far south as Lansing, wherever tamarack is to be found. We are still experimenting with the fungus diseases of this insect and plan to attempt the infection of the larvae still more extensively this summer.

The Adams appropriation has furnished funds for more work on insect diseases by myself and also for carrying on very satisfactory work on the problem on insecticides by Dr. Shafer. This latter problem is by nature a very complicated one and will require some time before final results are to be obtained, but very gratifying progress has been made during the entire year.

The change of quarters so kindly arranged by yourself has more than doubled the room at our disposal and added materially to the comfort and capacity of the division.

It remains to express grateful appreciation for the assistance and support of the two junior members of the division,—Dr. G. E. Shafer, whose work is entirely research and Mr. M. A. Yothers, half of whose time is devoted to station work, largely in general care of breeding experiments, keeping of records, and the various duties which are always coming to light. Both of these gentlemen have done their best toward working for the success of the division.

Respectfully submitted,
R. H. PETTIT,
Entomologist.

East Lansing, Mich., June 30, 1909.

REPORT OF SOIL PHYSICIST.

Director R. S. Shaw:

Dear Sir—Some time has been given to the study of the cement silo as it is found in Michigan, and a bulletin has been prepared on the same.

Special Bulletin No. 34 has been revised and reissued as Special Bulletin No. 47.

A circular on The Selection and Care of Seed Corn has been prepared.

Study has been given to soil thermometers with a view (1) to taking up a line of soil temperature investigation, and (2) to devising a simple and cheap, yet delicate and durable, soil thermometer.

Incidentally some preliminary work has been done in evaporimetry.

The large amount of class and other work has rendered it impossible to accomplish any considerable amount of investigation work, moreover the facilities for investigation will be limited until the new building is completed.

Respectfully,
JAS. A. JEFFERY,
Soil Physicist.

East Lansing, Mich., June 30, 1909.

REPORT OF THE VETERINARIAN.

Prof. R. S. Shaw, Director of Michigan Agricultural College Experiment Station:

Sir—During the past year ending June 30, 1909, nothing has been done by this department in an experimental way for the experiment station, although a large amount of correspondence has been carried on, some of which has been received through your office, some from the secretary and other departments, but the large proportion was received directly by this department. From this correspondence no serious outbreak of contagious disease may be reported although the matter of verminous disease of sheep seems to be somewhat on the increase. I believe that much good could be done along this line and would suggest that a popular bulletin be issued containing the known methods of treatment of the several forms of verminous infestations which are now known to be at least partially successful, and further that the experiment station should devote some time and funds to the trying out of these and other treatments under typical conditions, or perhaps in cooperation with sheep owners.

Respectfully submitted,
L. M. HURT.
Consulting Veterinarian of the Experiment Station.
East Lansing, Mich., June 30, 1909.

METEOROLOGICAL TABLES.

METEOROLOGICAL OBSERVATIONS.

Summary of the meteorological observations for 1908, at the Agricultural College, East Lansing, Michigan.

Months.	Mean daily temperature in open air.	Mean daily barometer reduced to freezing point.	Mean daily maximum temperature.	Mean daily minimum temperature.	Total rain and melted snow, inches.	Total snowfall, inches.
January	22.9	28.90	31.5	16.1	1.89	18.8
February	19.2	28.94	29.3	13.9	3.19	19.8
March	33.6	28.94	42.9	26.6	2.19	6.0
April	44.7	28.86	54.2	33.8	2.15	0.0
May	58.2	28.87	67.2	51.8	5.59	0.5
June	69.2	28.99	78.9	61.2	1.23	0.0
July	72.7	29.01	82.5	63.3	1.03	0.0
August	67.7	28.97	80.1	56.7	3.99	0.0
September	63.1	29.02	79.4	53.4	0.65	0.0
October	48.7	29.09	62.7	40.5	0.82	0.0
November	37.0	28.94	46.8	29.5	1.82	1.3
December	26.4	28.95	32.0	20.7	2.08	11.50
Year	47.0	28.96	57.3	39.0	26.63	57.9

Meteorological observations for the month of January, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	25	20	28.96	29.11	32	20	Cloudy	s w	0.0	0.0	1
2	17	29	29.17	29.16	32	11	Cloudy	s w	0.0	0.0	2
3	13	32	29.25	29.10	32	11	Pt. cloudy	s	0.0	0.0	3
4	36	28	28.65	28.93	37	28	Clear	w	0.0	0.0	4
5	15	23	29.14	29.05	28	15	Clear	w	0.0	0.0	5
6	24	34	28.91	28.72	38	22	Clear	s w	0.0	0.0	6
7	31	30	28.58	28.38	38	18	Pt. cloudy	s w	0.0	0.0	7
8	28	21	28.41	28.79	29	21	Cloudy	n	0.0	0.0	8
9	14	20	28.99	28.98	26	14	Pt. cloudy	e	0.0	0.0	9
10	25	30	28.91	28.98	36	18	Pt. cloudy	s	0.0	0.0	10
11	26	34	29.01	28.79	36	23	Cloudy	e	0.0	0.0	11
12	32	27	28.24	28.33	34	30	Cloudy	e	0.0	0.0	12
13	19	19	28.53	28.75	28	17	Pt. cloudy	n	0.50	5.00	13
14	27	27	28.93	28.96	30	13	Cloudy	w	0.0	0.0	14
15	25	29	28.74	28.66	35	18	Cloudy	s w	0.08	0.08	15
16	24	18	29.04	29.10	34	13	Clear	w	0.0	0.0	16
17	15	28	28.85	28.93	27	7	Cloudy	s w	0.0	0.0	17
18	20	30	29.17	29.09	35	18	Clear	s w	0.0	0.0	18
19	22	34	29.20	29.15	40	21	Clear	s w	0.0	0.0	19
20	33	35	29.02	28.93	40	20	Pt. cloudy	s w	0.0	0.0	20
21	36	41	28.81	29.60	42	30	Pt. cloudy	w	0.01	0.0	21
22	32	30	28.92	28.97	42	30	Clear	w	0.0	0.0	22
23	15	11	29.04	29.32	32	11	Clear	n w	0.0	0.0	23
24	10	22	29.26	28.84	24	8	Clear	s w	0.0	0.0	24
25	24	29	28.66	28.66	33	18	Cloudy	s w	0.0	0.0	25
26	27	27	28.34	28.18	32	25	Cloudy	e	0.0	0.0	26
27	10	16	28.64	28.76	27	10	Pt. cloudy	s w	0.60	6.00	27
28	23	14	28.51	28 78	28	14	Pt. cloudy	s w	0.10	1.00	28
29	–1	1	29.17	29.32	14	–1	Clear	n	0.0	0.0	29
30	–1	11	29.40	29.34	16	–11	Pt. cloudy	n e	0.0	0.0	30
31	13	18	29.22	28.63	20	7	Clear	s e	0.60	6.00	31
Sum	659	768	895.67	896.29	977	499			1.89	18.8	
Average	21.2	24.7	28.89	28.91	31.5	16.1					

Meteorological observations for the month of February, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	19	15	28.18	28.60	28	6	Pt. cloudy	w	0.30	3.00	1
2	6	8	29.01	28.97	26	8	Pt. cloudy	w	0.0	0.0	2
3	22	14	28.86	29.24	22	8	Pt. cloudy	w	0.03	0.03	3
4	3	13	29.40	29.38	18	–8	Clear	e	0.0	0.0	4
5	8	35	28.86	28.28	38	9	Cloudy	s	0.43	3.00	5
6	21	17	28.58	28.96	36	14	Cloudy	n w	0.23	2.00	6
7	16	17	29.29	29.40	34	12	Pt. cloudy	n	0.0	trace.	7
8	0	5	29.59	29.66	20	0	Clear	n	0.0	0.0	8
9	4	6	29.65	29.50	20	–3	Clear	e	0.0	0.0	9
10	3	36	29.41	29.34	42	13	Pt. cloudy	s e	0.0	0.0	10
11	23	39	29.29	29.22	48	22	Clear	e	0.0	0.0	11
12	36	42	29.06	28.93	42	33	Cloudy	s	0.04	0.0	12
13	40	33	28.97	29.04	42	33	Cloudy	w	0.0	0.0	13
14	32	32	28.84	28.42	34	30	Cloudy	n e	0.53	0.0	14
15	26	25	28.24	28.57	32	25	Cloudy	n	0.40	4.00	15
16	20	17	28.61	28.75	26	18	Cloudy	w	0.10	1.00	16
17	15	20	28.87	29.05	22	14	Cloudy	w	0.0	trace	17
18	15	20	29.09	28.80	23	14	Cloudy	n e	0.0	0.0	18
19	20	19	28.60	28.86	24	19	Cloudy	n e	0.60	6.00	19
20	8	22	29.12	28.95	28	6	Clear	w	0.0	0.0	20
21	23	20	28.85	28.88	29	20	Cloudy	w	0.0	trace	21
22	8	22	29.08	28.63	24	7	Pt. cloudy	s	0.0	0.0	22
23	22	22	28.78	28.92	29	21	Cloudy	n w	0.0	trace	22
24	3	28	29.09	28.85	27	0	Pt. cloudy	s	0.0	0.0	2
25	34	34	28.66	28.41	36	28	Cloudy	s w	0.48	0.0	25
26	22	16	28.43	28.64	34	18	Pt. cloudy	w	0.5	0.5	26
27	7	16	28.71	28.84	22	14	Pt. cloudy	w	0.0	trace	27
28	12	19	29.00	28.99	19	10	Clear	e	0.0	0.0	28
29	15	19	29.10	29.15	26	11	Clear	e	0.0	0.0	29
Sum	483	631	839.28	839.23	851	402			3.19	19.8	
Average	16.6	21.7	28.94	28.94	29.3	13.9					

Meteorological observations for the month of March, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	27	25	28.81	28.65	28	14	Cloudy	n e	0.50	6.00	1
2	26	23	28.83	29.04	29	22	Pt. Cloudy	w	0.0	0.0	2
3	20	27	29.27	29.35	30	17	Clear	w	0.0	0.0	3
4	22	31	29.38	29.30	38	19	Clear	e	0.0	0.0	4
5	29	31	29.20	28.94	38	32	Cloudy	e	0.10	0.0	5
6	36	37	28.44	28.48	50	32	Cloudy	n w	0.0	0.0	6
7	34	35	28.94	29.18	42	24	Pt. cloudy	w	0.0	0.0	7
8	34	31	29.12	29.20	42	28	Cloudy	w	0.0	0.0	8
9	17	32	29.42	29.40	34	14	Clear	w	0.0	0.0	9
10	19	40	29.48	29.23	46	14	Pt. cloudy	s w	0.0	0.0	10
11	39	42	29.05	28.84	52	35	Clear	w	0.0	0.0	11
12	38	47	28.81	28.76	54	35	Clear	w	0.0	0.0	12
13	44	36	28.69	28.78	48	38	Pt. cloudy	w	0.0	0.0	13
14	33	49	28.73	28.51	52	30	Cloudy	s w	0.0	0.0	14
15	38	37	28.40	28.72	48	36	Cloudy	n w	0.21	0.0	15
16	28	28	28.87	28.93	36	23	Cloudy	n	0.0	0.0	16
17	32	32	28.68	28.89	40	28	Pt. cloudy	w	0.0	0.0	17
18	29	30	28.77	28.76	32	29	Cloudy	n e	0.16	0.0	18
19	22	27	29.09	29.28	30	20	Pt. cloudy	n w	0.0	0.0	19
20	23	32	29.32	29.16	34	17	Pt. cloudy	s w	0.0	0.0	20
21	31	40	29.15	28.97	48	28	Clear	s w	0.0	0.0	21
22	35	43	28.78	28.82	50	31	Pt. cloudy	s w	0.0	0.0	22
23	40	43	28.66	28.49	55	33	Pt. cloudy	w	0.06	0.0	23
24	36	26	28.68	28.99	42	25	Clear	w	0.0	0.0	24
25	20	39	29.10	28.72	39	14	Pt. cloudy	e	0.0	0.0	25
26	58	38	28.63	28.90	70	39	Cloudy	n	0.0	0.0	26
27	31	40	29.08	28.80	42	30	Cloudy	e	1.03	0.0	27
28	40	37	28.78	28.96	52	32	Cloudy	w	0.0	0.0	28
29	33	35	29.07	29.18	38	20	Pt. cloudy	n w	0.0	0.0	29
30	33	43	29.27	29.00	44	28	Cloudy	s	0.0	0.0	30
31	41	43	28.82	28.92	46	38	Cloudy	s w	0.13	0.0	31
Sum	988	1,099	897.32	897.15	1,329	825			2.19	6.00	
Average	31.8	35.4	28.94	28.94	42.9	26.6					

Meteorological observations for the month of April, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	36	41	28.85	28.57	43	31	Cloudy	w	0.10	0.0	1
2	25	27	28.76	28.94	41	20	Cloudy	n w	0.0	0.0	2
3	26	28	29.02	29.09	35	22	Cloudy	w	0.0	0.0	3
4	29	40	29.12	29.09	40	16	Cloudy	s e	0.0	0.0	4
5	43	42.5	28.83	28.90	47	28	Cloudy	s	0.27	0.0	5
6	40	50	29.01	29.07	50	34	Pt. cloudy	e	0.0	0.0	6
7	38	39	29.17	29.02	63	35	Cloudy	n	0.53	0.0	7
8	41	35	28.64	28.99	48	35	Cloudy	n w	0.12	0.0	8
9	33	47	29.22	29.07	53	23	Clear	s w	0.0	0.0	9
10	46	49	28.81	28.69	60	39	Pt. cloudy	s	0.0	0.0	10
11	40	40	29.01	29.11	49	20	Clear	w	0.09	0.0	11
12	37	48	29.20	28.93	56	18	Clear	s	0.0	0.0	12
13	50	48	28.97	29.15	59	43	Clear	n	0.0	0.0	13
14	49	64	29.09	28.92	74	35	Clear	s	0.0	0.0	14
15	56	59	28.86	29.17	64	39	Pt. cloudy	n e	0.03	0.0	15
16	31	38	29.46	29.32	42	23	Clear	n e	0.0	0.0	16
17	36	53	29.24	29.04	60	27	Pt. cloudy	s e	0.0	0.0	17
18	44	55	28.76	28.68	58	43	Pt. cloudy	s	0.73	0.0	18
19	52	50	28.72	28.83	56	46	Pt. cloudy	w	0.0	0.0	19
20	47	44	28.68	28.86	54	41	Clear	n w	0.0	0.0	20
21	36	50	29.10	28.98	56	28	Clear	w	0.0	0.0	21
22	55	65	28.92	28.79	77	44	Clear	w	0.0	0.0	22
23	60	63	28.76	28.71	75	53	Cloudy	e	0.0	0.0	23
24	59	68	28.62	28.33	76	52	Cloudy	s	0.0	0.0	24
25	60	52	28.28	28.39	70	50	Cloudy	w	0.06	0.0	25
26	59	59	28.58	28.49	66	57	Pt. cloudy	w	0.01	0.0	26
27	46	40	28.34	28.49	59	37	Cloudy	s	0.15	0.0	27
38	37	39	28.44	28.68	40	23	Cloudy	w	0.06	0.0	28
29	38	41	28.78	28.89	44	22	Pt. cloudy	w	0.0	0.0	29
30	36	41	28.83	28.78	44	30	Cloudy	n	0.0	0.0	30
31	....	....	....	....	....	....	....	....	....	......	31
Sum	1,285	1,395	866.07	865.97	1,625	1,014	....	....	2.15	0.0	......
Average	42.8	46.5	28.86	28.86	54.2	33.8	....	....	....	......	....

Meteorological observations for the month of May, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	39	45	28.71	28.58	50	32	Pt. cloudy	w	0.0	0.0	1
2	34	41	28.49	28.78	46	28	Pt. cloudy	w	0.06	.50	2
3	47	50	28.91	28.90	54	31	Pt. cloudy	s w	0.0	0.0	3
4	44	48	28.92	28.97	58	38	Cloudy	s w	0.0	0.0	4
5	42	52	28.99	28.93	56	30	Cloudy	n e	0.0	0.0	5
6	43	43	28.84	28.75	52	41	Cloudy	n e	.09	0.0	6
7	45	47	28.45	28.44	48	42	Cloudy	n e	1.70	0.0	7
8	45	41	28.47	28.64	48	42	Cloudy	n	.13	0.0	8
9	47	58	28.73	28.72	62	38	Pt. cloudy	n w	0.0	0.0	9
10	56	62	28.93	28.81	70	42	Clear	w	0.0	0.0	10
11	62	62	28.77	28.68	64	47	Cloudy	s w	.11	0.0	11
12	66	68	28.59	28.82	76	61	Clear	s w	0.0	0.0	12
13	50	50	29.01	28.93	68	50	Cloudy	e	.30	0.0	13
14	49	50	28.99	29.07	51	49	Pt. cloudy	e	.76	0.0	14
15	51	71	29.00	29.05	71	50	Cloudy	s	.11	0.0	15
16	60	67	29.06	28.96	72	54	Pt. cloudy	s w	0.0	0.0	16
17	65	74	29.03	29.05	74	67	Pt. cloudy	s	0.0	0.0	17
18	62	68	29.01	28.79	74	59	Pt. cloudy	s e	.06	0.0	18
19	57	67	28.73	28.81	70	57	Pt. cloudy	e	.51	0.0	19
20	67	69	29.03	28.99	76	60	Clear	e	0.0	0.0	20
21	61	68	29.02	29.01	72	59	Clear	e	0.0	0.0	21
22	72	62	29.03	29.01	80	62	Pt. cloudy	s	0.0	0.0	22
22	66	68	29.20	29.20	78	62	Clear	s	0.0	0.0	23
24	69	71	29.28	29.13	76	66	Clear	e	0.0	0.0	24
25	67	69	29.06	28.99	85	59	Cloudy	s e	.33	0.0	25
26	70	72	28.78	28.71	78	61	Pt. cloudy	s w	.77	0.0	26
27	68	70	28.83	28.79	81	70	Pt. cloudy	s	0.0	0.0	27
28	73	67	28.75	28.78	78	64	Pt. cloudy	s w	.13	0.0	28
29	65	70	28.99	28.72	80	66	Pt. cloudy	s w	.34	0.0	29
30	63	66	28.75	28.66	74	65	Pt. cloudy	s	.19	0.0	30
31	48	48	28.79	29.04	66	50	Cloudy	s w	0.0	0.0	31
Sum	1,753	1,854	895.14	894.71	2,082	1,605			5.59	0.50	
Average	56.5	59.8	28.88	28.86	67.2	51.8					

Meteorological observations for the month of June, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	55	69	29.21	29.18	74	69	Clear	e	0.0	0.0	1
2	65	70	29.25	29.02	78	62	Clear	n e	0.0	0.0	2
3	65	68	29.07	29.00	74	61	Clear	e	0.0	0.0	3
4	68	75	29.04	29.00	80	64	Clear	n e	0.0	0.0	4
5	68	72	29.08	29.03	82	66	Clear	e	0.0	0.0	5
6	70	77	29.10	29.06	81	66	Pt. cloudy	s	0.0	0.0	6
7	74	79	29.04	28.96	85	64	Clear	s	0.0	0.0	7
8	67	78	28.88	28.76	86	64	Pt. cloudy	s	0.10	0.0	8
9	61	59	28.81	28.82	78	54	Cloudy	s w	0.0	0.0	9
10	55	69	28.86	28.90	67	54	Cloudy	s e	0.0	0.0	10
11	55	60	29.02	28.98	69	55	Clear	e	0.0	0.0	11
12	61	68	29.04	29.05	72	55	Pt. cloudy	e	0.0	0.0	12
13	69	65	28.88	28.75	76	60	Cloudy	s	0.45	0.0	13
14	63	58	28.76	29.03	69	58	Pt. cloudy	n	0.0	0.0	14
15	49	69	29.04	29.03	63	55	Clear	n	0.0	0.0	15
16	59	69	29.14	29.05	70	49	Clear	s e	0.0	0.0	17
17	61	67	29.11	29.01	71	59	Pt. cloudy	s e	0.0	0.0	16
18	72	80	28.97	28.95	86	60	Clear	s	0.0	0.0	18
19	79	87	28.76	28.81	88	60	Pt. cloudy	s w	0.30	0.0	19
20	71	74	28.98	28.89	88	61	Clear	s	0.0	0.0	20
21	77	79	28.90	28.99	85	65	Cloudy	s	0.01	0.0	21
22	79	83	28.98	28.98	90	70	Clear	s	0.0	0.0	22
23	79	78	28.91	28.83	89	70	Cloudy	s	0.0	0.0	23
24	70	69	28.94	29.04	79	68	Clear	s	0.0	0.0	24
25	68	65	29.22	29.18	75	63	Clear	s e	0.0	0.0	25
26	66	71	29.26	29.15	78	63	Clear	n w	0.0	0.0	26
27	68	77	29.12	29.00	84	64	Clear	s	0.0	0.0	27
28	75	72	28.97	28.92	87	63	Pt. cloudy	s	0.12	0.0	28
29	70	63	28.96	28.94	78	60	Cloudy	s e	0.25	0.0	29
30	65	67	29.03	28.99	84	62	Pt. cloudy	s	0.0	0.0	30
Sum	2,013	2,137	870.33	869.30	2,366	1,836			1.23		
Average	67.1	71.2	29.01	28.97	78.9	61.2					

Meteorological observations for the month of July, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	64	71	29.04	29.09	77	64	Clear	e	0.0	0.0	1
2	62	68	29.15	29.09	74	62	Pt. cloudy	n e	0.0	0.0	2
3	64	68	29.10	29.05	77	59	Cloudy	s	0.01	0.0	3
4	70	71	29.01	29.00	80	61	Cloudy	s	0.0	0.0	4
5	72	79	29.00	29.01	83	61	Pt. cloudy	s	0.0	0.0	5
6	80	82	29.06	29.03	89	67	Pt. cloudy	s	0.0	0.0	6
7	71	68	28.88	29.05	82	57	Clear	s e	0.0	0.0	7
8	60	70	29.18	29.08	75	57	Clear	s e	0.0	0.0	8
9	65	71	29.14	28.99	81	59	Clear	s	0.0	0.0	9
10	70	78	29.03	28.84	85	59	Clear	s	0.0	0.0	10
11	77	88	28.73	28.81	93	77	Clear	s e	0.0	0.0	11
12	80	88	28.90	28.84	92	77	Pt. cloudy	n w	0.0	0.0	12
13	73	81	28.95	28.84	89	70	Clear	s w	0.0	0.0	13
14	65	73	28.91	29.04	81	64	Clear	n e	0.19	0.0	14
15	65	71	29.10	29.04	79	62	Cloudy	n w	0.0	0.0	15
16	62	73	29.13	28.88	83	63	Pt. cloudy	n	0.0	0.0	16
17	69	76	28.69	28.62	79	63	Cloudy	s	0.53	0.0	17
18	70	66	28.64	28.79	76	66	Clear	s w	0.05	0.0	18
19	69	71	28.92	29.02	72	60	Pt. cloudy	e	0.25	0.0	19
20	64	70	29.07	29.00	72	65	Pt. cloudy	s	0.0	0.0	20
21	68	77	28.98	28.95	82	61	Pt. cloudy	s	0.0	0.0	21
22	72	74	29.02	29.01	82	72	Clear	e	0.0	0.0	22
23	68	78	29.10	29.10	78	60	Pt. cloudy	e	0.0	0.0	23
24	66	75	29.16	29.15	81	61	Clear	e	0.0	0.0	24
25	68	79	29.16	29.09	87	59	Clear	e	0.0	0.0	25
26	70	84	29.16	29.04	89	61	Clear	e	0.0	0.0	26
27	76	80	29.09	29.01	90	62	Clear	s e	0.0	0.0	27
28	76	80	29.06	29.00	92	62	Clear	s	0.0	0.0	28
29	80	85	29.10	29.01	92	63	Clear	e	0.0	0.0	29
30	75	81	29.06	29.00	97	63	Pt. cloudy	s e	0.0	0.0	30
31	71	71	29.04	29.05	81	68	Pt. cloudy	s e	0.0	0.0	31
Sum	2,162	2,347	899.56	898.52	2,560	1,964			1.03	0.0	
Average	69.7	75.7	29.02	28.99	82.5	63.3					

Meteorological observations for the month of August, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	68	74	29.06	28.93	86	52	Clear	s	0.0	0.0	1
2	70	81	28.92	28.86	90	58	Clear	s	0.0	0.0	2
3	75	85	28.88	28.84	95	62	Pt. cloudy	s	0.0	0.0	3
4	75	73	28.87	28.71	92	69	Cloudy	s	0.33	0.0	4
5	71	71	28.69	28.68	84	65	Clear	w	0.26	0.0	5
6	70	72	28.82	28.79	78	57	Pt. cloudy	w	0.0	0.0	6
7	62	70	28.90	28.81	78	54	Clear	w	0.0	0.0	7
8	62	68	28.94	28.88	78	61	Clear	n e	0.0	0.0	8
9	68	69	28.87	28.85	79	51	Pt. cloudy	s	0.0	0.0	9
10	61	66	28.86	28.82	77	58	Pt. cloudy	s w	0.03	0.0	10
11	65	78	28.90	28.85	87	53	Pt. cloudy	s e	0.0	0.0	11
12	69	71	28.77	28.88	83	58	Cloudy	s	1.05	0.0	12
13	67	75	28.85	28.95	81	66	Pt. cloudy	s w	0.19	0.0	13
14	70	73	29.07	29.18	86	62	Pt. cloudy	s e	0.0	0.0	14
15	67	68	29.16	29.09	75	61	Cloudy	s e	0.03	0.0	15
16	71	71	29.02	28.90	89	61	Pt. cloudy	s	0.90	0.0	16
17	71	71	28.91	28.95	84	60	Pt. cloudy	s	0.95	0.0	17
18	64	66	29.06	28.89	76	64	Clear	s	0.0	0.0	18
19	63	60	28.80	28.90	72	58	Pt. cloudy	n	0.24	0.0	19
20	55	63	29.07	29.00	70	43	Clear	s	0.0	0.0	20
21	58	68	28.95	28.83	77	48	Clear	s e	0.0	0.0	21
22	65	64	28.81	28.99	70	56	Clear	w	0.0	0.0	22
23	64	63	29.11	29.06	72	44	Clear	s w	0.0	0.0	23
24	54	59	29.15	29.17	67	45	Clear	e	0.0	0.0	24
25	52	61	29.20	29.13	70	48	Pt. cloudy	e	0.0	0.0	25
26	59	69	29.15	29.14	78	50	Clear	e	0.0	0.0	26
27	60	68	29.14	29.07	78	59	Clear	s e	0.0	0.0	27
28	61	68	29.08	28.99	78	53	Clear	s e	0.0	0.0	28
29	63	76	29.00	29.02	81	60	Cloudy	s e	0.01	0.0	29
30	68	77	29.14	29.11	87	61	Cloudy	e	0.0	0.0	30
31	70	80	29.16	29.07	88	62	Clear	s	0.0	0.0	31
Sum	2,018	2,178	898.31	897.34	2,486	1,758			3.99		
Average	65.1	70.2	28.98	28.95	80.1	56.7					

Meteorological observations for the month of September, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	69	66	28.98	28.95	79	64	Pt. cloudy	w	0.0	0.0	1
2	57	58	29.01	29.06	68	55	Pt. cloudy	w	0.0	0.0	2
3	44	61	29.19	29.06	85	35	Pt. cloudy	n	0.0	0.0	3
4	59	70	29.00	28.89	80	50	Pt. cloudy	s	0.0	0.0	4
5	63	73	28.90	28.78	81	59	Cloudy	s	0.0	0.0	5
6	71	68	28.72	28.89	77	60	Clear	n	0.0	0.0	6
7	54	63	29.11	29.11	73	43	Clear	e	0.0	0.0	7
8	52	68	29.25	29.17	74	46	Pt. cloudy	s	0.0	0.0	8
9	62	74	29.21	29.18	86	54	Clear	s	0.0	0.0	9
10	65	76	29.18	29.07	90	57	Clear	s	0.0	0.0	10
11	65	80	29.08	29.04	91	61	Clear	s	0.0	0.0	11
12	59	71	29.08	29.02	81	58	Clear	e	0.0	0.0	12
13	60	70	28.99	28.96	81	54	Pt. cloudy	n e	0.0	0.0	13
14	58	63	29.10	29.15	74	55	Clear	e	0.0	0.0	14
15	51	62	29.23	29.18	74	44	Clear	e	0.0	0.0	15
16	52	66	29.20	29.11	78	47	Clear	e	0.0	0.0	16
17	60	68	29.07	28.98	77	37	Pt. cloudy	n	0.0	0.0	17
18	58	74	28.93	28.87	85	54	Pt. cloudy	s w	0.0	0.0	18
19	65	68	28.97	29.02	86	60	Clear	s w	0.0	0.0	19
20	64	69	29.12	29.04	82	58	Pt. cloudy	n	0.0	0.0	20
21	61	78	29.09	29.02	93	60	Clear	e	0.0	0.0	21
22	66	74	29.02	28.92	88	62	Pt. cloudy	s	trace	0.0	22
23	66	72	28.98	28.99	78	64	Pt. cloudy	s	trace	0.0	23
24	65	71	29.11	29.07	80	63	Pt. cloudy	e	0.0	0.0	24
25	64	76	29.15	29.05	87	64	Clear	s	0.0	0.0	25
26	65	75	29.06	28.91	88	61	Clear	s	0.0	0.0	26
27	66	74	28.87	28.72	86	62	Clear	s	0.0	0.0	27
28	53	46	28.57	28.80	74	45	Cloudy	w	0.45	0.0	28
29	39	40	29.02	29.05	47	36	Pt. cloudy	s	0.11	0.0	29
30	45	51	28.79	28.82	59	34	Pt. cloudy	s	0.09	0.0	30
Sum	1,778	2,005	870.98	869.88	2,382	1,602			0.65		
Average	59.3	66.8	29.03	29.00	79.4	53.4					

Meteorological observations for the month of October, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation..		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	46	40	29.03	29.16	50	39	Pt. cloudy	n	0.03	0.0	1
2	35	41	29.30	29.25	54	30	Clear	n	0.0	0.0	2
3	39	54	29.33	29.26	65	32	Clear	n	0.0	0.0	3
4	44	54	29.33	29.26	74	34	Clear	e	0.0	0.0	4
5	46	62	29.24	29.10	76	37	Clear	e	0.0	0.0	5
6	54	64	29.07	29.01	76	49	Pt. cloudy	w	0.0	0.0	6
7	55	52	29.02	29.06	66	52	Pt. cloudy	n w	0.0	0.0	7
8	40	47	29.15	29.20	64	36	Pt. cloudy	n	0.0	0.0	8
9	36	48	29.24	29.13	59	30	Clear	n w	0.0	0.0	9
10	44	55	29.10	28.86	66	34	Clear	s	0.0	0.0	10
11	43	42	29.02	29.25	56	41	Clear	n	0.0	0.0	11
12	30	45	29.45	29.37	56	24	Clear	w	0.0	0.0	12
13	40	54	29.37	29.12	66	32	Clear	s	0.0	0.0	13
14	56	66	29.00	28.90	74	50	Clear	s w	0.0	0.0	14
15	60	65	28.94	28.86	78	57	Clear	s w	0.0	0.0	15
16	57	66	28.97	28.91	74	50	Clear	s w	0.0	0.0	16
17	56	66	29.05	29.04	78	56	Clear	s w	0.0	0.0	17
18	61	65	29.13	29.16	79	58	Clear	w	0.0	0.0	18
19	50	46	29.25	29.17	64	42	Clear	n	0.0	0.0	19
20	41	53	29.18	29.12	61	37	Clear	e	0.0	0.0	20
21	49	56	29.18	29.13	66	47	Clear	s	0.0	0.0	21
22	46	55	29.17	29.13	68	44	Clear	s e	0.0	0.0	22
23	48	60	29.13	29.00	67	45	Clear	e	0.0	0.0	23
24	56	61	28.75	28.73	61	51	Pt. cloudy	s e	0.75	0.0	24
25	42	49	28.82	28.79	61	39	Clear	s w	0.0	0.0	25
26	38	48	28.83	28.82	55	36	Pt. cloudy	n	0.03	0.0	26
27	44	45	28.89	28.90	48	41	Cloudy	n	0.01	0.0	27
28	43	45	28.96	28.95	53	40	Pt. cloudy	w	0.0	0.0	28
29	41	41	28.96	28.93	48	35	Pt. cloudy	w	0.0	0.0	29
30	31	38	29.07	29.13	41	28	Pt. cloudy	n w	0.0	0.0	30
31	33	33	29.24	29.30	39	30	Pt. cloudy	n	0.0	0.0	31
Sum	1,404	1,616	902.17	901.00	1,943	1,256			0.82	0.0	
Average	45.3	52.1	29.12	29.06	62.7	40.5					

Meteorological observations for the month of November, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	26	35	29.39	29.34	44	20	Clear	s w	0.0	0.0	1
2	34	43	29.33	29.19	51	29	Pt. cloudy	s w	0.0	0.0	2
3	37	55	29.03	28.65	57	27	Pt. cloudy	w	0.0	0.0	3
4	27	24	28.92	29.08	55	23	Pt. cloudy	n	0.0	0.0	4
5	26	36	29.11	28.99	38	16	Pt. cloudy	w	0.0	0.0	5
6	33	42	28.67	28.70	51	31	Pt. cloudy	w	0.0	0.0	6
7	39	40	28.73	28.52	43	34	Cloudy	s w	0.04	0.0	7
8	38	42	28.51	28.53	48	37	Pt. cloudy	w	0.03	0.0	8
9	38	40	28.68	28.83	47	37	Clear	n w	0.0	0.0	9
10	35	34	28.87	29.05	43	27	Pt. cloudy	n	0.0	0.0	10
11	28	28	29.04	29.15	38	23	Pt. cloudy	n	0.0	0.0	11
12	28	27	29.15	29.24	30	24	Cloudy	w	0.02	0.0	12
13	22	27	29.28	29.23	36	19	Pt. cloudy	w	0.0	0.0	13
14	26	24	29.09	28.91	28	21	Cloudy	s w	0.05	0.50	14
15	25	27	28.94	28.86	28	19	Cloudy	s	0.0	0.0	15
16	30	25	28.72	28.93	30	25	Pt. cloudy	w	0.07	0.75	16
17	19	38	28.90	28.63	38	17	Pt. cloudy	s w	0.0	0.0	17
18	37	39	28.67	28.60	44	36	Pt. cloudy	w	0.0	0.0	18
19	44	44	28.64	28.84	59	33	Pt. cloudy	w	0.0	0.0	19
20	34	39	29.17	29.18	51	30	Clear	e	0.0	0.0	20
21	29	43	29.18	29.13	55	27	Clear	s	0.0	0.0	21
22	38	60	29.12	28.99	64	36	Pt. cloudy	s	0.0	0.0	22
23	51	54	28.94	28.87	60	48	Cloudy	s	0.10	0.0	23
24	53	53	28.76	28.74	56	49	Cloudy	s	0.27	0.0	24
25	48	63	28.82	28.70	63	41	Cloudy	s e	0.10	0.0	25
26	48	40	28.73	29.07	63	36	Pt. cloudy	s w	0.18	0.0	26
27	34	32	29.23	29.35	40	32	Pt. cloudy	w	0.0	0.0	27
28	33	34	29.28	29.17	44	30	Pt. cloudy	w	0.0	0.0	28
29	29	40	29.09	28.92	43	28	Pt. cloudy	s	0.09	0.0	29
30	54	49	28.52	28.54	56	31	Cloudy	s w	0.87	0.0	30
Sum	1,043	1,177	868.51	867.93	1,403	886			1.82	1.25	
Average	34.8	39.2	28.95	28.93	46.8	29.5					

Meteorological observations for the month of December, 1908, at Agricultural College, East Lansing, Michigan.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	23	20	28.97	29.22	46	20	Pt. cloudy	w	0.0	0.0	1
2	15	20	29.37	29.39	20	12	Cloudy	w	0.0	0.0	2
3	20	30	29.35	29.06	30	13	Cloudy	s w	0.0	0.0	3
4	29	27	28.74	28.89	30	26	Cloudy	n w	0.05	0.50	4
5	17	25	29.10	29.16	28	13	Pt. cloudy	n e	0.0	0.0	5
6	26	32	29.01	28.69	32	23	Cloudy	s	0.15	1.50	6
7	27	15	28.65	29.01	32	15	Pt. cloudy	s w	0.02	0.20	7
8	13	23	28.99	29.00	23	12	Cloudy	s w	0.07	0.75	8
9	20	17	29.09	29.26	26	15	Pt. cloudy	w	0.0	0.0	9
10	10	29	29.26	28.94	29	5	Cloudy	s e	0.10	1.00	10
11	34	30	28.67	28.59	35	28	Cloudy	w	0.0	0.0	11
12	18	29	28.67	28.32	29	17	Cloudy	s w	0.11	1.10	12
13	28	28	28.49	28.67	34	24	Pt. cloudy	w	0.07	0.75	13
14	33	38	28.66	28.80	38	24	Cloudy	s	trace	trace	14
15	33	36	28.96	29.15	43	30	Clear	w	0.0	0.0	15
16	31	32	29.19	29.13	34	30	Cloudy	e	0.08	0.80	16
17	32	32	28.93	28.70	32	30	Cloudy	n	1.00	3.20	17
18	29	28	28.65	28.90	30	26	Cloudy	w	0.0	0.0	18
19	27	30	28.86	28.78	28	21	Cloudy	w	0.0	0.0	19
20	24	29	28.90	28.75	28	23	Pt. cloudy	s	0.02	0.25	20
21	29	25	28.94	29.23	31	24	Pt. cloudy	w	0.0	0.0	21
22	10	20	29.29	29.25	30	8	Clear	n	0.0	0.0	22
23	17	33	29.26	29.06	34	16	Cloudy	s	0.0	0.0	23
24	35	32	28.74	28.89	38	29	Cloudy	n	0.0	0.0	24
25	33	31	28.83	28.78	29	29	Pt. cloudy	s w	0.02	0.20	25
26	26	28	28.87	28.73	33	29	Pt. cloudy	w	0.0	0.0	26
27	33	30	28.63	28.89	30	25	Cloudy	w	0.0	0.0	27
28	20	30	29.14	29.03	34	14	Clear	s e	0.0	0.0	28
29	24	37	29.24	29.01	37	20	Cloudy	w	0.0	0.0	29
30	37	30	28.84	28.85	37	27	Cloudy	w	0.27	0.0	30
31	18	17	29.11	29.23	30	16	Cloudy	w	0.12	1.25	31
Sum	771	863	897.40	897.36	994	644			2.08	11.50	
Average	24.9	27.8	28.95	28.95	32.0	20.7					

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30, 1909.

EXPERIMENT STATION BULLETINS.

FERTILIZER ANALYSES.

ANDREW J. PATTEN, S. L. JODIDI, C. B. COLLINGWOOD.

SUMMARY OF FERTILIZER LAW.

Bulletin No. 252.

The inspection and analyses of the commercial fertilizers offered for sale in Michigan are made under authority of an act of the Legislature, approved March 10, 1885. The full text of the law has been printed in former bulletins, and its salient points alone will be referred to here. It provides that all commercial fertilizers, retailing for more than ten dollars per ton, shall be accompanied by a statement certifying the number of net pounds in the given sack, the brand, name and address of the manufacturer, and a chemical analysis stating the percentages of nitrogen, of potash soluble in water, of available (soluble and reverted) phosphoric acid, and the insoluble phosphoric acid. (Sec. 1.) It provides that the manufacturer, importer or agent (the latter only in case the manufacturer fails to comply with the law), shall pay annually a license fee of twenty dollars for each brand offered for sale. (Sec. 3.) It provides that any person offering unguaranteed or over-guaranteed goods, shall be subject to a fine. (Sec. 6.) The full text will be furnished on application.

LICENSED BRANDS.

Twenty-six manufacturers and fertilizer companies have licensed 149 distinct brands for sale in the state during the season of 1908. These brands, appearing in the following tables of analyses, and no others can be legally sold.

Parties manufacturing, importing or purchasing fertilizers for their own use and not for sale are not affected by the restrictions of the law.

COLLECTION OF SAMPLES.

The sampling agents of the station, during the months of April, May and June, drew 275 samples from dealers' stocks representing 136 different brands. The failure to get samples of 13 brands is due to the fact that many of them are sold only in the fall, then, too, a few companies sell direct to the consumer through the Grange and other organizations and consequently it is only by chance that samples of such goods are obtained. If persons ordering goods in this way wish to have them inspected they will protect themselves and at the same time confer a favor on this department by notifying us, and upon the arrival of the goods an inspector will be sent to draw samples.

It is the desire of this department to make the inspection as complete as possible, and any information to further this end from dealer or consumer would be greatly appreciated. In all cases of failure to find a brand on the market, the analysis was made on the manufacturer's sample as indicated in the tables of analyses.

RESULTS OF INSPECTION.

A study of the tables of analyses shows that, of the 171 samples analyzed, representing 149 brands, 43 (25%) are below guarantee* in one or more constituents. Fifteen (9%) are below guarantee in nitrogen, 8 (4.6%) are below guarantee in available phosphoric acid and 30 (17.5%) are below guarantee in potash. Seven (4%) are below guarantee in nitrogen and potash, 2 (1%) in nitrogen and available phosphoric acid, 3 (2%) in available phosphoric acid and potash and 2 (1%) in nitrogen, available phosphoric acid and potash.

This is a decidedly better showing than last year and there can be no question but that every company doing business in the state this year is doing its best to live up to the requirements of the law and the deficiencies should be considered as accidental rather than as deliberate attempts to defraud.

COMMERCIAL VALUATION.

In accordance with the custom adopted and followed in previous years, the following schedule of prices for determining the commercial valuation of a fertilizer is published:

Nitrogen	18½c	per	pound.
Potash soluble in water	5c	"	"
Available phosphoric acid	5c	"	"
Total phosphoric acid in bone	4c	"	"
Insoluble phosphoric acid in fertilizers containing nitrogen	2c	"	"

In fertilizers containing no nitrogen no value is given to insoluble phosphoric acid. The valuation of a fertilizer is determined as follows: The percentage or pounds per hundred of each ingredient (nitrogen, available phosphoric acid, insoluble phosphoric acid and potash) is multiplied by 20, giving the number of pounds of each ingredient in a ton. These figures are then multiplied by their respective pound prices.

It should be clearly borne in mind that, in publishing these prices, the station does not assume to dictate the price at which fertilizers shall be sold. Owing to the fluctuation in prices, differences in cost of delivery at different points, and other causes, the obtaining of true average market prices is an impossibility. The schedule of prices has been used by the station simply as a means of comparing the value of fertilizers as guaranteed by the manufacturer with the value of the samples as collected in the open market. Purchasers will often find these prices of use in comparing the relative values of similar brands offered by different manufacturers.

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* A shortage of more than 0.10 per cent of nitrogen or of more than 0.20 per cent of available phosphoric or potash is considered below guarantee.

AGRICULTURAL VALUE.

The agricultural value of a fertilizer is entirely distinct from the commercial value. The two have no true relation. The agricultural value of a fertilizer is measured by the value of the increase of crop produced by its use, and is naturally variable depending on many conditions. It is unquestionably true that any fertilizer has a greater agricultural value in some localities than in others, depending of course upon the character of the soil and somewhat upon the crop grown, at the same time however, the commercial value would be practically the same regardless of the locality.

Commercial fertilizers should be selected with the view of supplementing the natural resources of the soil and the manures produced upon the farm, consequently the agricultural value of the fertilizer would depend largely upon how wisely this selection was made.

COST OF COMMERCIAL FERTILIZERS.

It is probably true that a large percentage of the farmers using commercial fertilizers are largely influenced in their selection of a particular brand by the selling price, without giving due regard to the amount and kinds of plant food it contains. That this is so is evidenced by the large number of low and medium grade fertilizers found on sale throughout the state.

The particular value of a commercial fertilizer is to furnish to the growing crop the necessary elements of plant food, that is, nitrogen, phosphoric acid and potash, which the soil is no longer able to furnish in sufficient quantities. That fertilizer, then, which will supply the nitrogen, phosphoric acid and potash, in available forms, at the least cost per pound should be selected. It matters little under what name it is sold.

For the purpose of studying more closely the variation in the composition and cost per pound of the plant food elements, an arbitrary division has been made of complete fertilizers into four separate classes, based upon their commercial valuation; that is, the price at which the separate unmixed materials in one ton of fertilizer could be purchased for cash at retail in the larger fertilizer centers, such as Detroit and Chicago.

Our classification is as follows:

1. Low-grade fertilizers, those having a commercial valuation of less than $16.00 a ton.
2. Medium-grade fertilizers, those having a commercial valuation greater than $16.00 and less than $20.00 a ton.
3. Medium high-grade fertilizers, those having a commercial valuation greater than $20.00 and less than $25.00 a ton.
4. High-grade fertilizers, those having a commercial valuation greater than $25.00 a ton.

The 123 complete fertilizers analyzed are distributed among the four classes as follows:

Low-grade	29 or 23.6	per	cent.
Medium-grade	48 or 39.	"	"
Medium high-grade	23 or 18.7	"	"
High-grade	23 or 18.7	"	"

From these figures it will be seen that we are justified in saying that, of the complete fertilizers sold in this state during the present season, over 60 per cent were medium or low-grade in character. Only slightly more than one-sixth of the whole number could be termed strictly high-grade.

The following table shows the average amounts of nitrogen, available phosphoric acid and potash contained in the four different classes of complete fertilizer.

Class of fertilizer.	In 100 pounds of fertilizer.			
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of potash.	Pounds of total plant food.
Low grade	1.16	7.14	1.66	9.96
Medium-grade	1.33	9.54	2.74	13.61
Medium high-grade	1.83	8.67	5.95	16.45
High grade	2.74	9.88	8.11	20.73

Studying this table we notice the following points:

(1.) The percentage of available phosphoric acid is practically the same for all grades.

(2.) The percentage of nitrogen and of potash increases in the higher grades.

(3.) The total amount of plant-food in 100 pounds of fertilizer is greater in the higher grades.

In the next table is given the average actual selling price and the average commercial valuation of each grade of fertilizer and the excess of the selling price over the commercial valuation. As the commercial valuation represents the average retail price of the separate, unmixed materials contained in one ton of fertilizer at the large fertilizer centers of the middle west, the excess of selling price above commercial valuation represents the cost of mixing, bagging, the freight, profits and cost of business.

From a study of the following table we notice that the selling price varies considerably for any one grade of goods, and that this variation is entirely disproportionate to the value of the plant food. This difference is less marked in the high-grade goods. The excess of selling price over commercial valuation is greater in low-grade and medium-grade fertilizers than in high-grade fertilizers, that is, the high-grade fertilizers sell on an average, nearer to their actual plant food value than do the low-grade goods.

Selling price and commercial valuation of different grades of fertilizers.

	Low grade.	Medium grade.	Medium high grade.	High grade.
SELLING PRICE.				
Lowest	$16 00	$19 50	$25 50	$30 00
Highest	26 00	28 50	32 00	40 00
Average	21 80	24 15	27 96	34 85
COMMERCIAL VALUATION.				
Lowest	6 63	16 04	20 10	25 24
Highest	15 94	19 82	24 67	34 17
Average	13 67	17 80	22 12	29 46
DIFFERENCE BETWEEN SELLING PRICE AND COMMERCIAL VALUATION.				
Lowest	5 64	2 64	2 35	1 50
Highest	14 05	12 24	9 77	12 01
Average	8 13	6 35	5 84	5 39

Cost of One Pound of Plant-Food in Different Grades.

In the following table is shown the cost per pound to the purchaser of one pound of nitrogen, available phosphoric acid and potash in the different classes of fertilizers.

Cost of one pound of plant-food in different grades of fertilizers.

	Low grade.	Medium grade.	Medium high grade.	High grade.
COST OF ONE POUND OF NITROGEN.	Cents.	Cents.	Cents.	Cents.
Lowest	26.3	21.2	20.4	19.4
Highest	44.6	32.4	26.3	26.4
Average	30.5	25.2	23.6	22.2
COST OF ONE POUND OF AVAILABLE PHOSPHORIC ACID.				
Lowest	7.1	5.7	5.5	5.3
Highest	12.1	8.8	7.2	7.2
Average	8.2	6.8	6.4	6.0
COST OF ONE POUND OF POTASH.				
Lowest	7.1	5.7	5.5	5.3
Highest	12.1	8.8	7.2	7.2
Average	8.2	6.8	6.4	6.0

A study of the above table brings out several very interesting facts:

The cost of one pound of plant-food is greatest in the low-grade and lowest in the high-grade fertilizers. The highest cost for nitrogen, available phosphoric acid and potash in the high-grade fertilizers is not greater than the lowest cost for the same in the low-grade goods. The average price of nitrogen in the high-grade fertilizers is eight cents per pound cheaper than in the low-grade goods. The average price of phosphoric acid and potash in the high-grade fertilizers is two cents per pound cheaper than in the low-grade goods.

Thus it will be seen that more than ordinary attention should be given to the matter of purchasing commercial fertilizers if it is desired to obtain the plant-food at the lowest price per pound.

The following are the names of the parties from whose stocks the samples appearing in this bulletin were drawn:

Adair—C. H. Lipke.

Adrian—W. R. Bradish, Cutler Dickerson Co., J. Bennet, C. C. Vandoren, Chas. Eayrs, Clifford Ayers.

Almont—Frank Bishop, W. J. Merriam.

Bangor—J. Walher.

Battle Creek—J. E. Moon, Robt. Binder.

Benton Harbor—C. E. & C. H. Hilton, B. M. Nowlen Co.

Blissfield—Continental Sugar Co., M. Wolverton.

Butternut—Leon Richardson.

Caro—John F. Seeley.

Charlotte—F. C. Cobb & Co., Parker & McLaughlin.

Cheboygan—N. B. Keeney & Son.

Coldwater—W. C. Kempster, S. I. Treat & Son.

Coloma—Rube Hazen, Wm. Stratton.

Coopersville—Laug Bros., Reynolds Bros.

Davison—W. H. Parks, O. K. Hathaway.

Dearborn—Twork Bros.

Deerfield—Frank Timmins.

Detroit—Grandy Bros.

Dowagiac—Wm. Fiero, C. Shull.

Dundee—John E. Monk, W. B. Haines, Chas. VanFleet, W. S. Wells.

Eaton Rapids—W. E. Hale, J. E. Crane.

Elm—George Wolfrom.

Fillmore—J. Koop.

Fremont—Dirk Kolk.

Graafschap—Mulder & Brueker.

Grand Haven—Spiedel & Swartz.

Grand Rapids—Brown Seed Co., Jones Seed Co., Eagle Hide Co.

Hand Station—John H. Lange, Peter Flaishaus.

Harbor Springs—Chas. Fay.

Hartford—J. C. McAlpine.

Hillsdale—Wm. Cole, W. L. Kelley.

Holland—H. Harrington, B. J. Albers, Groenewald & DeVries.

Holly—J. C. Sheathelm, Joseph Robinson.

Hudson—H. D. Atherton, W. D. Rhead.

Ida—N. A. Weipert.

Imlay City—Fairweather & Steele, C. S. Marshall.

Inkster—A. L. Hanchett.

Jackson—James Boland Fert. Co., Isbell Seed Co.

Jasper—Service & Vanmarter.

Kalamazoo—Kalamazoo Rendering & Fert. Co.
Lansing—Artificial Stone Co., DuBois & Hughes, Briggs & Co.
Lenawee Junction—G. H. Jones.
Lenox—Ira Lovejoy, Farmers' Elevator Co., Richmond Elevator Co.
Manchester—Washtenaw Garden Co.
Mason—Chas. Field, John Bullen.
Maybee—W. L. Mack.
Memphis—J. H. Day, F. G. Coburn.
Milan—F. S. Olds, F. G. Hasley, Milton Hack.
Mt. Clemens—W. H. Chapman.
Mt. Pleasant—John N. Tucker.
Muskegon—John Stegink, J. E. Marvin.
Napoleon—Sigmond Bros.
North Branch—E. & V. E. Simmons.
Palmyra—P. P. Cook.
Petersburg—H. A. Logan, Clark J. Cilley.
Pittsford—Carl & Childs.
Port Huron—M. H. Baldwin.
Quincy—Turner & Hoover.
Raisin Center—F. V. Judson.
Reading—Wm. Cahaw, E. Van Sickel.
Redford—Hugh Houk, C. A. Lasher, Albert David.
Ridgeway—Harry Wood.
Romeo—Bradley & Chubb.
Royal Oak—Peter Backer.
Saginaw—Stingel Bros.
St. Clair—Geo. C. Solis.
St. Joseph—E. Burton.
St. Louis—Frank Obrey.
Smiths Creek—Lewis Brill.
Springport—J. H. Hammill & Co.
Strasburg—C. W. Rau.
Swartz Creek—N. Burleson.
Taylor Center—August Boelter.
Tecumseh—Brown & Co., Slayton & Son.
Utica—A. R. Hon, Church & Church.
Vassar—W. G. Lewis.
Vreeland—J. Van Heilzma.
Warren—F. A. Reddick, Peter Wolff.
Washington—P. P. Andrews, J. F. Dunburger.
Waterford—Wm. R. King.
Zeeland—D. Hunderman, Haan & Hungerink, Henry Scholten, Isaac VanDyke Co.

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1786	The American Agricultural Chemical Co..........	Bradley's Alkaline Bone and Potash..
1662	The American Agricultural Chemical Co..........	Bradley's B. D. Sea Fowl Guano......
1668	The American Agricultural Chemical Co..........	Bradley's Dissolved Bone with Potash..
1828	The American Agricultural Chemical Co..........	Bradley's Dissolved Bone with Potash..
1664	The American Agricultural Chemical Co..........	Bradley's Soluble Dissolved Bone....
1663	The American Agricultural Chemical Co..........	Bradley's Special Potash Fertilizer....
1665	The American Agricultural Chemical Co..........	Crocker's Ammoniated Wheat and Corn Phosphate........................
1796	The American Agricultural Chemical Co..........	Crocker's Dissolved Bone and Potash..
1787	The American Agricultural Chemical Co..........	Crocker's General Crop Phosphate....
1667	The American Agricultural Chemical Co..........	Crocker's New Rival Ammoniated Superphosphate....................
1666	The American Agricultural Chemical Co..........	Crocker's Universal Grain Grower....
*1811	The American Agricultural Chemical Co..........	Fine Ground Bone....................
1669	The American Agricultural Chemical Co..........	High Grade Garden and Vegetable Fertilizer.........................
1670	The American Agricultural Chemical Co..........	Michigan Ten Per Cent Potash Fertilizer..........................
1671	The American Agricultural Chemical Co..........	New York State Special.............

*Manufacturers' sample.

for 1908, expressed in pounds in one hundred.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	....	11	1	12	2
Found............	....	11.61	1.54	13.15	1.81
Claimed..........	2.06	8	....	9	1.50
Found............	2.19	9.81	1.04	10.85	1.49
Claimed..........	1.00	8	....	10	2
Found............	1.14	9.66	1.29	10.95	1.86
Claimed..........	1.00	8	....	10	2
Found............	1.16	9.26	1.22	10.48	2.00
Claimed..........	....	11	1	15	....
Found............	....	**13.64**	2.34	15.98	....
Claimed..........	0.82	8	....	10	3
Found............	1.04	9.62	1.23	10.85	2.86
Claimed..........	2.05	8	....	9	1.50
Found............	2.29	10.21	1.04	11.25	1.50
Claimed..........	....	10	....	12	2
Found............	....	11.31	1.64	12.95	2.03
Claimed..........	0.82	7	....	8	1
Found............	0.93	8.05	1.50	9.55	1.05
Claimed..........	1.23	9	....	10	2
Found............	1.23	10.78	1.02	11.80	2.05
Claimed..........	0.82	8	....	9	2
Found............	0.95	9.64	1.29	10.93	2.24
Claimed..........	2.46	....	....	20	....
Found............	2.86	....	....	26.60	....
Claimed..........	2.00	8	....	....	5
Found............	2.60	9.09	1.39	10.48	5.40
Claimed..........	0.82	5	....	7	10
Found............	0.87	5.93	0.84	6.77	10.67
Claimed..........	0.82	8	....	10	3
Found............	1.14	9.40	1.20	10.60	2.87

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1829	The American Agricultural Chemical Co..........	New York State Special.............
1661	The American Agricultural Chemical Co..........	Bradley's Niagara Phosphate.........
*1812	The American Agricultural Chemical. Co.........	Niagara Dissolved Bone and Potash..
1672	The American Agricultural Chemical Co..........	Niagara Grain and Grass Grower.....
1673	The American Agricultural Chemical Co..........	Niagara Potato and Vegetable Fertilizer
1674	The American Agricultural Chemical Co..........	Niagara Wheat and Corn Producer....
1675	Armour Fertilizer Works........................	All Soluble........................
1676	Armour Fertilizer Works........................	Ammoniated Bone with Potash......
*1813	Armour Fertilizer Works........................	Banner Brand.......................
1677	Armour Fertilizer Works........................	Bone, Blood and Potash.............
1830	Armour Fertilizer Works........................	Bone, Blood and Potash........ ....
1678	Armour Fertilizer Works........................	Bone Meal........................ .
1679	Armour Fertilizer Works........................	Crop Grower........................
1680	Armour Fertilizer Works........................	Fruit and Root Crop Special........
1681	Armour Fertilizer Works........................	Grain Grower.......................

*Manufacturers' sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	0.82	8	....	10	3
Found............	0.93	9.61	1.29	10.90	3.50
Claimed..........	0.82	7	....	8	1.00
Found............	0.84	8.41	1.44	9.85	1.04
Claimed..........	....	10	1	11	2
Found............	....	11.20	1.55	12.75	2.43
Claimed..........	0.82	7	....	8	1
Found............	1.11	8.02	1.23	9.25	1.05
Claimed..........	2.06	8	....	10	3
Found............	2.13	9.61	0.74	10.35	3.14
Claimed..........	1.23	9	....	10	2
Found............	1.24	10.61	1.52	12.13	1.91
Claimed..........	2.88	8	....	10	4
Found............	3.27	8.46	3.17	11.63	4.99
Claimed..........	2.47	6	....	8	2
Found............	2.74	6.55	2.40	8.95	**1.50**
Claimed..........	....	10	0.50	10.50	8
Found............	....	10.86	0.19	11.05	8.96
Claimed..........	4.11	8	....	10	7
Found............	**3.81**	11.68	2.10	13.78	**5.82**
Claimed..........	4.11	8	....	10	7
Found............	**3.72**	11.80	2.00	13.80	**6.78**
Claimed..........	2.47	....	....	24	....
Found............	2.71	....	....	28.20	....
Claimed..........	1.23	8	....	10	2
Found............	1.45	8.44	1.81	10.25	2.62
Claimed..........	1.65	8	....	10	5
Found............	1.84	8.01	3.34	11.35	6.38
Claimed..........	1.65	8	2	10	2
Found............	1.74	8.10	2.88	10.98	2.46

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1683	Armour Fertilizer Works	High Grade Potato
1682	Armour Fertilizer Works	German Kainit
1715	Armour Fertilizer Works	Muriate of Potash
1684	Armour Fertilizer Works	Nitrate of Soda
1685	Armour Fertilizer Works	Sulphate of Potash
1686	Armour Fertilizer Works	Phosphate and Potash
1687	Armour Fertilizer Works	Raw Bone Meal
1688	Armour Fertilizer Works	Star Phosphate
1689	Armour Fertilizer Works	Steamed Bone Meal
1690	Armour Fertilizer Works	Sugar Beet Special
1691	Armour Fertilizer Works	Wheat, Corn and Oats Special
1692	Bash Fertilizer Company	Bash's Ideal Grain Grower
1831	Bash Fertilizer Company	Bash's Ideal Grain Grower
1693	Robert Binder	Blood and Bone Fertilizer
1694	James Bolan Fertilizer Works	Blackman General Crop Fertilizer

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed	1.65	8		10	10
Found	1.79	9.03	0.42	9.45	13.70
Claimed					12
Found					12.48
Claimed					48
Found					56.50
Claimed	15.63				
Found	15.58				
Claimed					49
Found					**48 38**
Claimed		10		12	2
Found		11.42	0.66	12.08	1.96
Claimed	3.70			22	
Found	3.91			25.10	
Claimed		14		18	
Found		14.74	0.46	15.20	
Claimed	1.65			20	
Found	1.68			20.83	
Claimed	0.82	8		10	4
Found	1.19	10.51	0.24	10.75	4.04
Claimed	0.82	7		10	1
Found	1.54	9.55	1.23	10.78	2.62
Claimed	1.60	8	1	9	2
Found	**1.29**	8.60	0.45	9.05	1.87
Claimed	1.60	8	1	9	2
Found	**1.42**	**7.36**	0.42	7.78	**1.37**
Claimed	5.25			13.17	
Found	5.20			19.30	
Claimed	1.25			7	1.25
Found	2.73	8.77	6.53	15.30	1.61

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1695	James Bolan Fertilizer Works	Blackman Brand Sugar Beet, Onion and Potato
1832	James Bolan Fertilizer Works	Blackman Brand Sugar Beet, Onion and Potato
1696	E. Burton	Meat and Bone Phosphate
1697	The Buffalo Fertilizer Co	Ammoniated Bone Black
1698	The Buffalo Fertilizer Co	Bone Meal
1699	The Buffalo Fertilizer Co	Celery and Potato Special
1833	The Buffalo Fertilizer Co	Celery and Potato Special
1700	The Buffalo Fertilizer Co	Farmers Choice
1701	The Buffalo Fertilizer Co	Garden Truck
1834	The Buffalo Fertilizer Co	Garden Truck
1702	The Buffalo Fertilizer Co	Muriate of Potash
1704	The Buffalo Fertilizer Co	Ohio and Michigan Special
1810	The Buffalo Fertilizer Co	General Crop
1845	The Buffalo Fertilizer Co	General Crop
1705	The Buffalo Fertilizer Co	Soluble Bone

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed	2.50	...	...	10	3
Found	2.60	10.02	6.78	16.80	2.22
Claimed	2.50	...	...	10	3
Found	2.50	10.12	7.46	17.58	2.34
Claimed	3.00	...	...	15	0.36
Found	4.51	...	...	13.43	0.21
Claimed	1.23	8	...	9	2.50
Found	1.16	10.72	1.38	12.10	3.13
Claimed	2.46	...	...	22	...
Found	3.05	...	...	20.35	...
Claimed	1.64	8	...	9	10
Found	1.98	8.97	1.43	10.40	6.92
Claimed	1.64	8	...	9	10
Found	2.06	11.51	1.79	13.30	9.01
Claimed	0.82	8	...	9	5
Found	0.91	9.94	1.34	11.28	6.27
Claimed	3.28	8	...	9	7
Found	3.37	10.15	1.40	11.55	5.38
Claimed	3.28	8	...	9	7
Found	3.16	9.75	1.32	11.07	7.41
Claimed	...	...	...	...	48
Found	...	...	...	...	48.76
Claimed	0.82	10	...	11	1
Found	0.76	10.75	1.05	11.80	2.49
Claimed	...	9	1	10	3
Found	...	11.04	1.74	12.78	2.17
Claimed	...	9	2	10	3
Found	...	11.01	1.69	12.70	2.82
Claimed	...	14	...	15	...
Found	...	14.11	2.92	17.03	...

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1706	The Buffalo Fertilizer Co.	York State Special
1711	Chicago Fertilizer Co.	Bone, Blood and Potash
1826	Chicago Fertilizer Co.	Potash Special
1712	Chicago Fertilizer Co.	Potato, Truck and Tobacco
1710	Chicago Fertilizer Co.	Wheat and Corn Special
1788	Cincinnati Phosphate Co.	Capital Cereala
1707	Cincinnati Phosphate Co.	Capital Dissolved Bone
1708	Cincinnati Phosphate Co.	Capital Grain and Grass Grower
1709	Cincinnati Phosphate Co.	Capital Tobacco, Potato and Beet Grower.
1835	Cincinnati Phosphate Co.	Capital Tobacco, Potato and Beet Grower
1716	Cincinnati Phosphate Co.	Capital Truck and Tobacco
1789	Cincinnati Phosphate Co.	Capital Wheat Grower
1713	Darling & Company	Darling's Acid Phosphate
1714	Darling & Company	Big Potash Brand
1836	Darling & Company	Big Potash Brand

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	1.64	9	....	10	5
Found............	1.80	10.89	0.91	11.80	5.26
Claimed..........	1.20	8	....	10	2
Found............	1.35	10.51	0.99	11.50	2.55
Claimed..........	0.82	8	....	....	4
Found............	0.96	9.23	1.85	11.08	5.01
Claimed..........	1.64	8	....	10	4
Found............	1.90	10.00	0.68	10.68	5.16
Claimed..........	0.82	7	....	9	1
Found............	0.98	8.78	1.60	10.83	1.22
Claimed..........	0.80	7	1	....	1
Found............	1.00	8.71	1.49	10.20	1.87
Claimed..........	....	10	....	11	4
Found............	....	10.72	1.28	12	4.04
Claimed..........	1	8	1	9	2
Found............	1.21	10.03	0.75	10.78	2.11
Claimed..........	0.80	8	....	....	4
Found............	0.86	8.54	1.21	9.75	**3.74**
Claimed..........	0.80	8	....	....	4
Found............	0.94	9.89	0.97	10.36	4.01
Claimed..........	1.60	6	....	7	6
Found............	**1.33**	9.22	0.73	9.95	**4.99**
Claimed..........	....	12	1	....	....
Found............	....	13.31	2.34	15.65	....
Claimed..........	....	10	....	....	....
Found............	....	11.75	0.35	12.10	....
Claimed..........	1.23	8	....	10	10
Found............	1.26	9.65	2.65	12.30	9.87
Claimed..........	1.23	8	....	10	10
Found............	1.56	10.06	1.94	12	10.11

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1719	Darling & Company	Darling's Chicago Brand
1718	Darling & Company	Darling's Farmers' Favorite Brand
1720	Darling & Company	Darling's General Crop Brand
1855	Darling & Company	Darling's Pure Bone and Potash
1721	Darling & Company	Darling's Pure Ground Bone
1722	Darling & Company	Darling's Sure Winner Brand
1723	Darling & Company	Darling's Vegetable and Lawn Fertilizer
1837	Darling & Company	Darling's Vegetable and Lawn Fertilizer
1724	Darling & Company	Darling's Western Brand
1725	Grand Rapids Glue Co	Grand Rapids
1798	Grange Fertilizer Co	Michigan Grange All Crops Special
*1815	Grange Fertilizer Co	Michigan Grange Complete Manure
1807	Grange Fertilizer Co	Michigan Grange Corn, Oats and Grass Fertilizer
1808	Grange Fertilizer Co	Michigan Grange Potato and Vegetable Fertilizer
1799	Grange Fertilizer Co	Michigan Grange Wheat Fertilizer

*Manufacturers' sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	1.65	8	....	10	2
Found............	1.97	10.65	2.33	12.98	3.28
Claimed..........	2.47	8	....	10	4
Found............	2.65	9.78	3.65	13.43	4.68
Claimed....	0.82	8	....	10	6
Found............	0.94	9.64	1.16	10.80	7.12
Claimed...........	2.14	....	....	20.15	6
Found............	**1.91**	....	....	23.92	6.34
Claimed..........	2.50	....	.. . .	23	.. ..
Found...........	2.53	....	....	24.18	....
Claimed..........	0.82	8	....	10	3
Found......... ...	0.90	8.96	1.24	10.20	3.15
Claimed..... .	3.30	8	....	9	7
Found......	**2.94**	10.67	0.46	11.13	**6.26**
Claimed..........	3.30	8	....	9	7
Found............	3.65	9.59	0.36	9.95	8.06
Claimed........ .	0.41	7	....	9	0.50
Found.....	0.49	10.64	0.46	11.10	0.73
Claimed..	2	8	7	15	1
Found........... .	2.88	8.62	11.48	20.10	**0.46**
Claimed.....	1.00	8	....	10	2
Found............	1.19	9.44	1.41	10.85	2.00
Claimed..........	0.82	7	1	8	1
Found......... ...	1.04	8.04	1.74	9.78	1.03
Claimed..........	1.64	8	....	....	2
Found............	1.74	9 69	1.46	11.15	2.07
Claimed..	0.85	8	....	9	4
Found............	1.11	9.42	2.11	11.53	4.09
Claimed..........	....	14	....	15	..
Found............	....	14.71	2.29	17.00	....

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1800	Grange Fertilizer Co	Michigan Grange Wheat Fertilizer with Potash
*1844	Hirsh, Stein & Co	Calumet Brand Grain Grower
*1816	The Jarecki Chemical Co	C. O. D. Phosphate
1726	The Jarecki Chemical Co	Fish and Potash, Potato and Tobacco Food
1727	The Jarecki Chemical Co	Lake Erie Fish Guano
1728	The Jarecki Chemical Co	Little Giant Fish Guano
1729	The Jarecki Chemical Co.	Number One Fish Guano
1730	The Jarecki Chemical Co	Special Sugar Beet Grower
1731	The Jarecki Chemical Co	Square Brand Phosphate and Potash.
1732	The Jarecki Chemical Co	Tobacco and Truck Grower
1733	Kalamazoo Rendering and Fertilizer Co	Kazoo Fertilizer
*1817	Michigan Carbon Works	Banner Dissolved Bone
1735	Michigan Carbon Works	Homestead Bone Black Fertilizer
1734	Michigan Carbon Works	Homestead A. I. Potash Fertilizer
1737	Michigan Carbon Works	Homestead High Grade Garden and Vegetable Fertilizer

*Manufacturers' sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed	...	10	...	11	2
Found	...	11.42	1.80	13.22	2.04
Claimed	1.60	8	1	9	2
Found	2.46	8.68	0.53	9.21	2.10
Claimed	...	12	1	...	...
Found	...	12.27	2.63	14.90	...
Claimed	0.83	8	...	9	4
Found	0.94	9.00	1.88	10.88	4.06
Claimed	1.25	8	...	9	2.50
Found	1.24	9.69	1.51	11.20	2.80
Claimed	0.83	7	...	8	1
Found	0.93	8.38	1.42	9.80	1.72
Claimed	1.04	8	...	9	2
Found	1.10	9.08	1.05	10.13	2.02
Claimed	0.83	8	...	...	4
Found	0.88	7.90	2.15	10.05	3.90
Claimed	...	10	1	11	2
Found	...	10.98	1.72	12.70	2.10
Claimed	1.66	6	...	...	6
Found	2.06	6.94	0.84	7.78	6.85
Claimed	3.00	2	10	12	4.50
Found	**2.75**	2.94	6.31	9.25	5.79
Claimed	...	34	1	35	...
Found	...	35.24	0.21	35.45	...
Claimed	2.06	8	...	9	1.50
Found	2.26	9.92	0.81	10.73	1.50
Claimed	0.82	8	...	10	3
Found	0.86	9.10	1.60	10.70	3.17
Claimed	2.06	8	...	...	5
Found	2.04	9.78	0.90	10.68	5.08

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1738	Michigan Carbon Works	Homestead Ten Per Cent Potash Manure
1740	Michigan Carbon Works	Homestead Special Beet Fertilizer
1741	Michigan Carbon Works	Homestead Sugar Beet Fertilizer
1736	Michigan Carbon Works	Pure Animal Bone and Potash
1742	Michigan Carbon Works	Red Line Complete Manure
1743	Michigan Carbon Works	Red Line Phosphate
1790	Michigan Carbon Works	Red Line Phosphate with Potash
1744	Michigan Carbon Works	Wolverine Phosphate
1745	North Western Fertilizing Co	Acidulated Bone and Potash
1747	North Western Fertilizing Co	Garden City Superphosphate
1746	North Western Fertilizing Co	Horse Shoe Corn and Wheat Grower
1748	North Western Fertilizing Co	Horse Shoe High Grade Vegetable Fertilizer
1749	North Western Fertilizing Co	Horse Shoe Potash Manure
1753	North Western Fertilizing Co	Horse Shoe Sugar Beet Fertilizer
1791	North Western Fertilizing Co	Horse Shoe Special Onion and Vegetable Manure

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	0.82	5	....	7	10
Found............	1.07	6.15	1.05	7.20	10.57
Claimed..........	1.65	8	....	10	5
Found............	1.78	9.65	0.80	10.45	5.59
Claimed..........	1.23	9	....	10	2
Found............	1.29	10.81	0.87	11.68	2.19
Claimed..........	0.82	....	....	22	10
Found............	0.95	....	....	24.48	11.67
Claimed..........	0.82	7	....	8	1
Found............	0.93	8.15	1.48	9.63	1.19
Claimed..........	....	14	....	15	....
Found............	....	15.09	2.86	17.95	....
Claimed..........	....	10	....	11	2
Found............	....	10.92	1.56	12.48	2.26
Claimed..........	....	10	....	11	....
Found............	....	10.89	2.09	12.98	....
Claimed..........	0.82	10	....	12	1
Found............	0.95	11.18	1.62	12.80	1.26
Claimed..........	2.00	8	....	10	1.50
Found............	2.18	9.10	1.45	10.55	1.65
Claimed..........	1.64	8	....	10	2
Found............	1.71	9.33	1.37	10.70	**1.71**
Claimed..........	2.00	8	....	....	5
Found............	2.09	9.84	1.47	11.31	5.34
Claimed..........	0.82	8	....	10	3
Found............	1.25	9.68	1.45	11.13	2.84
Claimed..........	1.23	9	1	....	2
Found............	1.31	10.21	1.14	11.35	1.93
Claimed..........	0.82	5	....	7	10
Found............	0.90	4.98	0.90	5.88	11.92

Results of analysis of commercial fertilizers

Laboratory Number.	Manufacturer.	Trade Name.
1751	North Western Fertilizing Co.	Quick Acting Phosphate
1801	Ohio Farmers Fertilizer Co.	Ammoniated Bone and Potash
1802	Ohio Farmers Fertilizer Co.	Corn, Oat and Wheat Fish Guano
*1792	Ohio Farmers Fertilizer Co.	General Crop Fish Guano
1827	Ohio Farmers Fertilizer Co.	Soluble Bone and Potash
1757	The Packers Fertilizer Association	Boar's Head Corn and Wheat Grower
1848	The Packers Fertilizer Association	Boar's Head Corn and Wheat Grower
1758	The Packers Fertilizer Association	Boar's Head Faultless Grain Fertilizer
1759	The Packers Fertilizer Association	Boar's Head High Grade Vegetable Fertilizer
1795	The Packers Fertilizer Association	Boar's Head Potash Phosphate Fertilizer
1847	The Packers Fertilizer Association	Boar's Head Potash Phosphate Fertilizer
1760	The Packers Fertilizer Association	Boar's Head Sure Growth Potash Manure
1761	The Pulverized Manure Co.	Wizard Brand Shredded Cattle Manure
1843	The Pulverized Manure Co.	Wizard Brand Shredded Cattle Manure
1762	The Pulverized Manure Co.	Wizard Brand Pulverized Hog Manure

*Manufacturer's sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed		10		12	
Found		11.20	1.88	13.08	
Claimed	0.82	8		10	4
Found	0.93	9.24	0.98	10.22	5.53
Claimed	1.20	8		10	2
Found	1.64	9.15	1.10	10.25	2.42
Claimed	0.82	7		9	1
Found	0.88	8.08	2.50	10.58	1.59
Claimed		10			2
Found		11.57	1.78	13.35	2.41
Claimed	1.65	8		10	2
Found	1.92	8.92	1.55	10.47	1.84
Claimed	1.65	8	2	10	2
Found	1.67	9.63	1.24	10.87	2.02
Claimed	0.82	7		8	1
Found	0.98	7.96	1.44	9.40	1.07
Claimed	1.64	8		10	5
Found	2.25	9.11	1.27	10.38	5.19
Claimed		10		12	5
Found		10.52	1.67	12.19	**4.66**
Claimed		10		12	5
Found		10.16	1.86	12.02	**4.37**
Claimed	0.82	8		10	3
Found	0.91	9.00	1.75	10.75	3.21
Claimed	1.90	1.10		1.50	1.45
Found	**1.50**	**0.54**	0.14	0.68	**0.48**
Claimed	1.90	1.10		1.50	1.45
Found	2.08	1.02	0.26	1.28	**1.21**
Claimed	1.90	1.10		1.50	1.45
Found	1.83	1.13	0.11	1.24	**0.90**

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1763	The Pulverized Manure Co....................	Wizard Brand Pulverized Cattle Manure
1793	Rasin-Monumental Co........................	Rasin's Wheat and Truck Mixture....
1764	Speidel and Swartz..........................	Celery Hustler.....................
*1824	Stingel Bros................................	Stingel's General Purpose...........
*1825	Stingel Bros..	Stingel's Sugar Beet Grower.........
1765	Swift & Company.......	Swift's Pure Bee Hive Fertilizer......
1838	Swift & Company............................	Swift's Pure Bee Hive Fertilizer......
1766	Swift & Company...	Swift's Pure Bone Meal.............
1767	Swift & Company............................	Swift's Pure Complete Fertilizer......
1839	Swift & Company............................	Swift's Pure Complete Fertilizer......
*1819	Swift & Company....	Swift's High Grade Muriate of Potash..
1859	Swift & Company.......	Swift's Pure Garden City Phosphate..
1770	Swift & Company........	Swift's Pure Onion, Potato and Tobacco Fertilizer........................
1771	Swift & Company........	Swift's Pure Special Park and Lawn Fertilizer........................
1773	Swift & Company............................	Swift's Pure Special Phosphate and Potash.........................

* Manufacturers' sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	1.90	1.10	....	1.50	1.45
Found............	2.37	0.97	0.12	1.09	**1.18**
Claimed..........	....	10	1	....	8
Found............	....	10.08	2.12	12.20	8.04
Claimed..........	6.00	3.17	0.69	3.86	1.25
Found............	6.90	3.43	0.78	4.21	1.58
Claimed..........	4.00	8	....	17.00	....
Found............	4.05	9.18	8.77	17.95	....
Claimed..........	3.00	7	....	15	8
Found............	3.18	8.70	6.62	15.32	8.44
Claimed..........	0.82	8	....	....	3
Found............	1.04	9.39	1.46	10.85	**2.69**
Claimed..........	0.82	8	....	....	3
Found............	1.24	**7.45**	1.51	8.96	**2.49**
Claimed..........	2.50	....	....	25.00	....
Found............	**2.38**	....	....	27.00	....
Claimed..........	1.00	8	....	11	1
Found............	1.14	8.48	1.64	10.12	1.20
Claimed..........	1.00	8	....	11	1
Found............	1.42	8.90	0.93	9.83	**1.75**
Claimed..........	....	....	....	....	58
Found............	....	....	....	....	61.46
Claimed..........	....	14	1	15	....
Found............	....	15.83	1.65	17.48	....
Claimed..........	1.65	8	....	11	7
Found............	1.85	8.88	1.65	10.53	7.07
Claimed..........	6.58	7	....	....	....
Found............	**6.27**	7.30	2.65	9.95	....
Claimed..........	....	10	....	11	2
Found............	....	13.38	1.15	14.53	**1.48**

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1774	Swift & Company	Swift's Pure Sugar Beet Grower
1840	Swift & Company	Swifts' Pure Sugar Beet Grower
1775	Swift & Company	Swift's Pure Superphosphate
1776	Swift & Company	Swift's Pure Truck Grower
1841	Swift & Company	Swift's Pure Truck Grower
1777	Swift & Company	Swift's Pure Vegetable Grower
1842	Swift & Company	Swift's Pure Vegetable Grower
*1820	Swift & Company	Swift's Special Sugar Beet Grower
*1821	Tuscorora Fertilizer Co	Acid Phosphate
1778	Tuscarora Fertilizer Co	Ammoniated Phosphate
1803	Tuscarora Fertilizer Co	Bone and Potash
1780	Tuscarora Fertilizer Co	Michigan Special
1804	Tuscarora Fertilizer Co	Steamed Bone Meal
*1822	Tuscarora Fertilizer Co	Tuscarora Bone Phosphate
1805	Tuscarora Fertilizer Co	Tuscorora Fruit and Potato

*Manufacturers' sample.

for 1908, expressed in pounds in one hundred.—Con.

	Nitrogen.	Phosphoric acid			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed	2.50	8		11	5
Found	**2.35**	8.93	3.12	12.05	6.72
Claimed	2.50	8	3	11	5
Found	3.29	9.55	4.08	13.63	6.15
Claimed	1.65	8		12	2
Found	1.97	8.74	1.56	10.30	2.07
Claimed	0.82	8		10	4
Found	0.96	8.91	1.19	10.10	**3.71**
Claimed	0.82	8		10	4
Found	0.96	9.73	0.70	10.43	4.48
Claimed	3.29	9		10	10
Found	3.30	**8.67**	2.58	11.25	11.28
Claimed	3.29	9	1	10	10
Found	3.19	10.23	2.29	12.52	10.41
Claimed	4.12	8	2	10	7
Found	**2.67**	9.61	1.89	11.50	**5.49**
Claimed		14	0.50	14.50	
Found		**13.72**	0.36	14.08	
Claimed	0.82	7		9	1
Found	1.10	9.03	1.22	10.25	1.20
Claimed		10		12	2
Found		12.43	0.55	12.98	2.09
Claimed	1.65	8		10	5
Found	1.80	**7.50**	3.55	11.05	7.87
Claimed	1.65			20	
Found	1.99			24.63	
Claimed		10	0.50	10.50	
Found		**9.38**	0.32	9.70	
Claimed	1.65	8		10	10
Found	1.67	10.02	0.78	10.80	**9.79**

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer.	Trade Name.
1779	Tuscarora Fertilizer Co	Tuscarora Garden
1781	Tuscarora Fertilizer Co	Tuscarora Standard
1782	Tuscarora Fertilizer Co	Tuscarora Trucker
1806	Tuscarora Fertilizer Co	Wolverine Special
1784	Montgomery Ward & Co	Ward's Excelsior Corn Fertilizer
1785	Wuichet Fertilizer Co	Buckeye Onion and Truck Fertilizer

for 1908, expressed in pounds in one hundred.—Concluded.

	Nitrogen.	Phosphoric acid.			Potash soluble in water.
		Available.	Insoluble.	Total.	
Claimed..........	2.83	8	....	10	4
Found	**2.29**	8.52	2.76	11.28	4.13
Claimed..........	1.65	8	....	10	2
Found............	1.72	8.04	2.56	10.60	2.45
Claimed..........	4.11	8	....	10	7
Found............	**3.65**	10.12	4.41	14.53	7.60
Claimed..........	0.82	8	....	10	4
Found............	1.70	9.01	0.87	9.88	5.24
Claimed..........	1.65	3.49	....	5.24	2
Found............	2.22	8.04	1.89	9.93	2.11
Claimed..........	1.50	8	....	10	8
Found............	1.71	9.57	2.98	12.55	**7.05**

FOREWORD.

S. B. HARTMAN AND H. J. EUSTACE.

Bulletin No. 253.

Upon many Michigan farms are mature apple orchards that have been neglected for many years and have produced no income further than an occasional small crop of apples of uncertain quality.

With a little investment and a little work at the proper time, many of these orchards, —if located upon congenial soil and not too old,—can be made to return a cash income that will be an important item in the farm economy.

An account, in detail, of the methods used and results secured with such orchards, handled in connection with general farming, is herein given by Mr. S. B. Hartman, of Athens, Calhoun county. His results should stimulate farmers to make an effort to turn similar orchards into a source of profit and fruit supply for home use.

THE ORCHARDS.

In the following pages are given in detail the experiences of the author in handling three aged and neglected apple orchards for a period of five years, together with a tabulation of costs and income.

The first orchard consists of 30 trees, most of which are about 30 years old. This orchard has been in sod and used as a hog pasture for at least 15 years, and previous to 5 years ago had never had a good pruning. The varieties and number of trees of each variety are as follows: 11 Stark, 3 Maiden Blush, 3 Winter Rambo, 2 Ben Davis. 2 Steele Red, 2 Baldwin, 2 Golden Russet, 2 Rhode Island Greening, 1 Winter Pippin, 1 Fameuse, 1 Yellow Transparent.

The second orchard consisting of 14 trees is a remnant of the old orchard on another part of the farm, the average age being about 40 years. These trees are scattered and the ground has been used in a regular rotation of farm crops. Varieties are as follows: 4 Northern Spy, 2 Jonathan, 4 Ben Davis, 2 Russet, 1 Baldwin, 1 Fall Pippin.

The third orchard consisting of 8 trees is a remnant of an old orchard on the home farm. Two of the trees are younger, but most of them are from 50 to 60 years of age. The orchard has been in a regular rotation of crops, but is now included in a young orchard. Varieties are as follows: 3 Northern Spy, 2 King, 1 Bellflower, 1 Tolman Sweet, 1 Red Astrachan.

In all there are 52 trees, which if collected and placed 36 feet apart would cover 1.6 acres at 33 trees to the acre.

WORK AND RESULTS FOR THE FIRST YEAR, 1904.

Nothing was done to the orchards this season except to pick the fruit, which for some years previous had been allowed to go to waste. Apples were abundant this year and prices very low. The writer had taught school the previous year and had the farm work to do during the summer, but found time during the fall to pick the apples rather than see them go to waste. The only money expended in harvesting was $7 for help in picking. No provision had been made for shipping, so most of the fruit was sold to local buyers at 40 cents per hundred weight, or about 20 cents per bushel. We drove four miles to the orchard in the morning, put the apples into the crates from the picking sacks, and drove home with the load in the evening, unloading at the car the next morning. In all about a car-load of apples was sold for $126.37. Money costs, including shipping boxes purchased later and packing were $19.34, leaving a net balance of $107.03 to pay for 18 days labor of myself and team, or about $6 per day.

Fifty-three bushels of the best of this fruit were sorted out, packed in bushel apple boxes and consigned to a Chicago firm. These sold for 85 cents per box. This set me to thinking that if this fruit could be so cared for that a larger per cent would be perfect, the increased receipts would more than offset the added expense. Accordingly, we prepared to give the orchard some care the following season.

WORK AND RESULTS SECOND YEAR, 1905.

A good brass pump with two leads of 20-foot hose, 8 and 10-foot bamboo brass-lined extension rods, two double vermorel nozzles, and a good brass strainer were purchased, the entire outfit costing $27.50.

The orchard of 8 trees near home was pruned at a cost of $2, but help was scarce and spring work pressing, and no pruning was done on the other orchards.

The pruned orchard was sprayed four times; a part of the other trees twice, with Bordeaux mixture, just before and just after blossoming, at a cost of $15 for labor and materials.

This was an off year, and the crop very light, yet it was better and larger than in the neighboring orchards, and the foliage had a more healthy appearance and remained on the trees longer in the fall.

The cost, including labor of picking, grading, packing, and marketing the crop, was $13.70; packages for early apples, $1.56; pruning, $2, and spraying $15, as noted above; total expense for the season, $32.26.

The late apples were consigned to a Chicago firm, selling for 90 cents and $1 per bushel; and the early apples were sold to neighbors at from 50 cents to 85 cents per bushel, the total sales being $46.23, leaving a net balance of $13.97.

No account was made of the apples used by three families. Hired labor was charged at cost; my time at $1 per day; team at $1 per day.

WORK AND RESULTS THIRD YEAR, 1906.

The spraying of the previous year had given the trees a more thrifty growth, and the light crop allowed them to mature numerous fruit buds, so most of the trees set a good crop.

The youngest orchard was pruned this spring and the home orchard pruned again. All trees that had been pruned and the best unpruned ones in the third orchard were given four applications of Bordeaux and Paris Green as follows: 1st application May 3-5, before blossoms opened; 2nd, May 22-26, after blossoms fell; 3rd, June 6-7; 4th, August 5-7.

About 750 bushels were picked. The apples were put in barrels and crates and hauled to the barn on the home farm. After the picking season was over, these were graded and packed. Most of the crop was sold F. O. B. Athens at 75 cents per bushel box for fancy, $1.75 per barrel for No. 1 and $1.25 for No. 2. The early fruit was consigned to a commission house and some winter fruit was sold to home consumers. Apples were quite abundant in the locality and prices medium to low. The itemized account for the season is as follows:

Pruning	$10.75
Spraying	36.82
Picking and packing	80.20
Packages	49.08
Labels	2.25
Total cost	$179.10
Apples sold	404.74
Net profit	$225.64

Winter fruit for family use is credited at 50 cents per bushel, but no credit was made for early fruit, cider, vinegar, and apple butter, for three families, or for apples consumed by hogs.

A small orchard was also sprayed for a neighbor, he doing the pruning and paying for the spraying, and we harvesting and marketing the surplus fruit on halves. This amount to $42.96 this season.

WORK AND RESULTS FOURTH YEAR, 1907.

The San Jose scale now made its appearance in the orchards. It was already pretty well established on several trees and scale marks could be found on the fruit from nearly every tree. During April and early May, we sprayed these orchards thoroughly with lime and sulphur wash, going over the trees twice with the wind in opposite directions. This wash was made by cooking the concentrated materials in barrels with steam from the saw mill near home, whence they were hauled in closed barrels to the orchards four miles away. Enough was cooked in the morning to last during the day and diluted as used. The cost of this spraying was $26.27.

One spraying with Bordeaux mixture was also given at a cost of $22.02.

The best trees of the orchard hitherto unpruned were thinned out through the year, the total pruning bill being $10.

The crop was light, about 100 bushels, but there were no apples in the neighborhood, and the fruit sold readily to neighbors at from 75 cents to $1.25 per bushel. The total cost was $74.74, the gross returns $89.25, leaving a net profit of $14.51.

Labor during this year is charged at $1.50 per day, and $1 per day for team.

WORK AND RESULTS FIFTH YEAR, 1908.

The pruning this year was chiefly the removal of sprouts and dead limbs, and amounted to less than the average required.

Four sprayings were made. The first just before the blossoms opened, using 3 lbs. of copper sulphate, 5 to 10 lbs. of lime, and ¼ lb. Paris Green to 50 gallons of water, applied with a hand pump. The second and third sprayings were made the last of May, and June 10, after the blossoms fell; in these, 3 lbs. arsenate of lead took the place of the Paris Green. The fourth spraying was made August 7 and 8, and 1½ lbs. arsenate of lead and 1-6 lb. Paris Green was used and only one-half as much copper sulphate and lime as in the previous sprayings. The Paris Green was used to piece out a limited supply of arsenate of lead.

The fruit set abundantly on 16 trees of Red Astrachan, Fameuse, Winter Rambo, Jonathan, Baldwin, Northern Spy, and Ben Davis. It was thought advisable to thin them and it was done at an average cost of 25 cents per tree.

In picking, the fruit was gathered and put directly into apple and cracker barrels and orange boxes, and set on a low-down wagon with bolster springs beneath the platform and hauled to the barn. Baskets were used in the main for picking, but on high trees both baskets and sacks were used to save trips up and down the ladder.

One hundred thirty-one bushels were sold to farmers or villagers who secured them from the orchard or storage; 41 barrels of summer fruit were consigned to a Chicago commission house; 71 barrels of winter fruit were sold to grocers and consumers, and the balance, or about two-thirds of the winter fruit, was sold to a cold storage company, the car being loaded with the barrels and crates just as picked from the trees.

Eighty-eight bushels of picked fruit, which was on hand (Nov. 15), or distributed to neighbors and friends, are credited as sold, but no account is made of the fruit used by three families and given away during the summer, or of the cider apples which did much toward supporting a drove of hogs, and furnished cider, vinegar, and apple butter for several families.

The items of all the expenses of producing and harvesting the crop for this season are as follows

Hauling 23 loads of manure	$7.00
Pruning	2.70
Spraying, four applications	59.74
Thinning	3.95
Packages	71.74
Picking, packing, and hauling	81.30
Total expense	$226.43
Apples sold, 984 bushels	700.74
Net profit	$474.31

The manure was secured for the hauling, so no charge was made for it. All labor is charged at $1.50 per day, team $1. The spraying chemicals cost 8½ cents per pound for copper sulphate; 35 cents per pound for Paris Green; 10 cents per pound for arsenate of lead, and ground lime cost 20 cents per 40-pound sack. The sulphate was purchased the previous year when prices were higher.

Apple barrels are charged at 40 cents each, which covers the cost of barrel, hauling and nailing; cracker barrels at 15 cents, which covers the cost and labor in repairing them; orange boxes at 3 cents.

SUMMARY OF RECEIPTS AND EXPENSES.

It is interesting for the sake of comparisons and averages to bring together the receipts and expenses from these orchards for the five years. They are as follows:

Year.	*Receipts.*	*Expenses.*	*Net profit.*
1904	$126.37	$19.34	$107.03
1905	46.23	32.26	13.97
1906	404.74	179.10	225.64
1907	89.25	74.74	14.51
1908	700.74	226.43	474.31
			$835.46 for five years.

Receipts for 5 consecutive years	1,367.33
Expenses for 5 consecutive years	531.87
Average *net profit* per year for 5 consecutive years	167.09
Average net profit *per acre* per year	104.43

In the five years there have been three good crops, while in the other years, not much more than expenses were realized. But the fact that even in these "small" years the orchards were given thorough sprayings and other care, has made the "big" years possible.

The average net profit per year per acre will certainly compare favorably with any farm crop, and is discussed under the next heading.

COMPARISONS.

Three other small orchards of from ten to twenty trees each were sprayed for neighbors, but were not given the first spraying before the blossoms opened. The fruit was more scabby and the trees not so uniformly nor so heavily loaded, but each orchard contained more fruit than the families needed. From one of these orchards, we picked 32 bushels of fruit after the family was supplied; from another we purchased 50 bushels and as many more were given away or sold to neighbors; while from the third, we harvested $63.06 worth of apples on shares after three families had been supplied. Unsprayed orchards in close proximity to each of these bore next to nothing.

In one of the old orchards, five trees of varieties like the other nine were left unpruned and unsprayed. One of these trees, which promised some fruit, was given the last two sprayings, and several barrels of fairly good fruit were picked from it. Another tree yielded a bushel of wormy and scabby fruit, and the others, none worth picking. All blossomed full.

The young orchard of an acre yielded about 750 bushels of fruit, or an average of about 25 bushels per tree. This yield is interesting, chiefly when compared with that of the surrounding orchards, as it probably contained more good fruit than all the other orchards in the adjacent two or three townships. Three small orchards which were sprayed for neighbors all had fair crops of fruit. These orchards have been object lessons and have demonstrated to all unbelievers that there is virtue in spraying.

Within a half mile of the one-acre orchard, are two orchards of the same age. One has been well pruned, but not sprayed, and yielded about enough fruit for a family. The other had been neither pruned nor sprayed and yielded nothing worth picking.

This season, the weather at blossoming and some time later, was warm and moist, ideal conditions for the rapid development of the apple scab fungus. This worked upon the stems and blossoms and young fruits, causing them to drop profusely. It got such a vigorous start upon the remaining fruit and the foliage and so weakened it, that with the drought of late summer and fall, the trees dropped a large part of the fruit they had been able to carry through the June drop. Upon many of the trees, three-fourths of the unsprayed fruit had dropped by October 1st, while the dropping was not above normal on the well-sprayed trees.

Aside from the orchards previously mentioned, we have contracted two more for a six-year period, and have an option on a third. One of these contains about 75 trees from 10 to 70 years of age, and they are in fair condition, with just a touch of the scale. We have spent nine days pruning this orchard at a cost of $13.50, exclusive of burning the brush.

The second orchard is a different proposition. Trees are good varieties, mostly Northern Spy, but crowded and badly infested with the scale. The trees are not high, but half the limbs are killed by scale and crowding, and its care will be something of an experiment, but I believe it will pay out. We have pruned 40 of the best trees at a cost of $10.50. A power sprayer with three-horse engine and 200 gallon tank has been purchased, and we shall soak these scale-infested trees with lime-sulphur in the spring, which I think will soon put new vigor into them.

CAN THE GENERAL FARMER AFFORD TO GROW APPLES?

It is proper to consider whether the general farmer can grow apples as a farm crop, or more particularly, whether he can afford to care for the trees now on the farm so as to grow fruit for the family use and for sale, provided there are enough trees.

The orchards above described have been handled in connection with general farming operations and small fruits, with the additional disadvantage of two of them being four miles from home. The size is about the same as the average orchard in many farming sections, and about the same difficulties are presented, including the unavoidable use of the orchard for stock, the presence of San Jose scale, and the previous neglect.

In addition to returning a cash profit that averaged $167.09 for the past five years,—as previously mentioned,—they have furnished fruit for several families and considerable food for stock. During this time, the trees have been brought from a state of neglect to fairly good condition. The work has been done without encouragement from, and against the advice of, relatives and friends, and without the investment of a cent of capital not secured from the trees themselves. Neither has any farm nor small fruit crop been neglected on account of the apple orchard.

It seems reasonable to suppose that any farmer who has the willingness to care for his orchard and will follow a few plain directions can do as well or better. It will be difficult for many farmers to name a crop that will give a greater net income for a series of years, and at the same time involve less risk or require less capital. To make a measurable success of such a proposition, a farmer must have a little love, or at least *respect* for his trees, and perform the operations upon them in a careful manner and at the proper times. If the spraying is left until he can find nothing to do, it will never be done on time, and often will not be effective. The farmer is then quite likely to conclude that spraying is of no value. Some fruit of fair quality can be grown without spraying, in some seasons considerable good fruit, but a good paying crop is never assured without spraying; should it chance to come, it is generally when fruit is abundant in the neighborhood and consequently cheap. During the past few years, there have been few instances of good crops from unsprayed orchards.

There are arguments against the care of small apple orchards by stock or general farmers, and the arguments are sufficient for those to whom the care of an orchard is distasteful, if they *will purchase and keep on hand during the season such fruit as a good home orchard will furnish.* This proviso well nigh nullifies the statement, for few farmers will or can provide such a supply of apples during the entire season as a good orchard will furnish.

The chief difficulty in caring for a small orchard is the spraying. Fairly good fruit can be grown without cultivation, if some mulching or manure is applied, and a home orchard can often be utilized as a hog pasture much of the season. The pruning is not difficult if the trees are not too badly neglected, and there is a latitude of time in which to do it, time too when the farm work is not pressing; but the spraying, or at least a part of it, must be done at certain times, for a delay of a week will make a great difference in the results. It must be done thoroughly. That spraying must be done to grow good fruit is a settled fact, and in regions where the San Jose scale is present, it is another settled fact that spraying must be done to save the trees.

This spraying could be done by those who make it a business to furnish apparatus and materials and go from farm to farm spraying small orchards for less than it would cost the farmer who owns a few trees. If some reliable party can be found to do this, and do it on time, by all means secure him, and pay the price without grumbling. But few can command such service, and must do the work for themselves, if it is done at all. The outfit need consist only of a good brass pump with barrel, 25 feet of hose, a good 8 to 10-foot extension rod, and one or more standard nozzles, the whole costing from $20 to $25, which is only a fraction of the equipment needed to grow other crops. If San Jose scale is present, an iron kettle is needed in which to cook lime and sulphur wash, unless one prefers to purchase the ready-made commercial preparations. A barrel or two for mixing the materials and a one-horse buggy or wagon, or even an ordinary wagon, to carry the spray barrel can be found on every farm, and generally there is a spare horse to draw the outfit. A half-day, or at most a day, two to four times a year will suffice to spray an orchard of from 25 to 50 trees, according to size.

HINTS ON IMPROVING NEGLECTED ORCHARDS.

Before undertaking to improve a neglected orchard, some facts should be considered. Look to the varieties and make sure they are good kinds, such as are known and in demand. Usually the more trees of one good variety, the better, for it is more satisfactory to have good sized shipments of one variety than small lots of many kinds.

The trees should not be too old; an old, worn-out tree can not take on new life. In general, it can be said that the trees should not be more than 30 to 35 years old. There are instances where it has paid to work with older trees, but they are unusual cases. If they are too badly broken or diseased, or too seriously weakened by long infestation with San Jose scale, or over 35 to 40 per cent of them have died out, it probably will not pay to attempt to improve the orchard.

Further consideration must be given to location, air and soil drainage. An orchard cannot be expected to pay if it is located in a pocket or on flat land where spring frosts are likely to destroy the fruit buds, or on an exposed site where the fruit buds will be frequently winter killed. Trees will not flourish upon poorly drained soil. The lack of drainage in an orchard is often manifest by a crooked and twisted trunk. Unless there is good natural drainage, it must be provided. Tile (3-inch) are more satisfactory than anything else, and the amount necessary depends, of course, upon the soil. They should be laid below the frost line and have a fall of not less than 2 inches in a hundred feet.

The first job will probably be pruning. Do not make the common mistake of overdoing it. To do all the pruning that may seem desirable at one time, would bring forth a forest of water sprouts in the spring. Begin in March by taking out the dead and broken limbs and the suckers. In June, cut off the water sprouts and take out a few of the interfering branches. Aim to open the top and let in sunshine and allow a free circulation of air, for both are needed to help produce fine fruit. Do not cut off a large limb until you are sure it is necessary. In removing limbs, cut back as close as possible. The wounds will then heal over quickly, while if a stub or stump is left, it cannot heal and decay will begin. Paint all large wounds. Spread the job of pruning over several years. The balance between root and top can be controlled in this way. If the trunks and limbs are covered with old, shaggy bark,—as they probably are,—they should be scraped. Many insects and diseases find a place to hibernate under the bark. Tools for this work are manufactured, or one can be made of an old hoe. Do not scrape down too close.

Probably for some years, the trees have been in sod and have not had any fertilizer and are in the process of starvation. The sod must be broken up. Plow it up as well as it can be done. If the orchard has been in sod for a long time, many of the roots will be near the surface and some will be cut off; but the plowing will do many times more good than the injury to a few roots. After plowing, work down with a harrow. A good job can hardly be expected the first year, especially if the orchard has been neglected for some years, but improvements can be made every season. It will be likely that some fertilizer must be provided. It is advisable to proceed with caution in giving fertilizer at the beginning; a moderate dressing of barnyard manure is better than anything else.

Give several cultivations with a harrow until the early part of July and at the last one sow the seeds of some cover crop broadcast. There are many plants that are useful for the purpose. Some of them are the clovers, the Mammoth and Crimson are usually the best. The vetches are very good, but have to be plowed under early in the spring and the seed is somewhat expensive. A combination of common field peas and barley is also good. Soy beans are successful in the north, especially the early varieties. All of these plants are nitrogen gatherers and add nitrogen to the soil. Some of the non-nitrogenous crops are rye, barley, oats and buckwheat; of these the buckwheat is probably the best.

The usual quantity of seed to use per acre is, of mammoth or Alsike clover, 12 pounds; crimson clover, 15 pounds; soy beans, 1½ bushels; field peas, 1½ bushels; buckwheat, 1 bushel; rye, 1½ bushels: barley and peas, each 1 bushel.

The advantages of a cover crop are, to check the growth of the trees late in summer so they go into the winter in a hardy condition; to prevent washing of the soil by the fall and spring rains, and upon loose soils or where the slope is sharp, this is an important factor, and one of the greatest arguments for the use of a cover crop; to assist in holding the leaves that will decay and be plowed under; to hold the snow which may prevent injury to the roots, and to add humus to the soil. On light, thin soils the supply of humus soon becomes exhausted. It can be supplied by the application of barnyard manure, but it is cheaper and easier to supply it by the use of a cover crop.

By using nitrogenous plants for the cover crop, nitrogen will be added to the soil. These plants have the power of collecting nitrogen from the air, storing it in the nodules on the roots, and when they are plowed under and decay, this nitrogen becomes available as plant food. Nitrogen is an expensive fertilizer to buy, and with a good cover crop, there will be no need to secure a further supply.

Spraying must be made a regular practice. The neglected trees have probably sheltered insects and diseases for some years that must be subdued by thorough and regular spraying, as is directed farther on.

These are general directions for improving an orchard that has not been paying for itself. Good judgment must be used in all the operations. Do not carry any one operation to excess or to the neglect of others. The trees are being stimulated along several lines as pruning, cultivating, fertilizing and spraying, and each must be an accompaniment to the others.

Success depends upon many things, but the first thing is the man. To undertake this work in a half-hearted way will discourage success.

THE SPRAYING OF APPLE ORCHARDS.

Michigan apple orchards cannot be relied upon to bring forth crops of clean, sound apples in paying quantities unless thoroughly sprayed. Apples must be of good size, attractive in appearance and sound, free from worms and blemishes, so that they will keep in storage for their normal length of time; and unless the trees, fruit and foliage are insured against the attacks of insects and fungous troubles that are apt to come at any time, such fruit cannot be expected to mature.

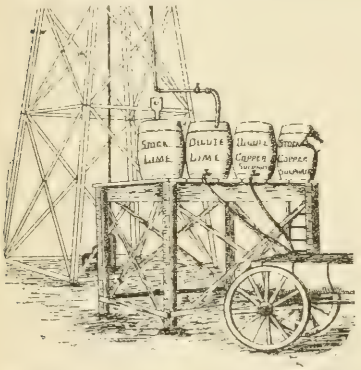
Fruit and foliage are kept free from these troubles by a very thin film of spraying mixture, the spore, which is the seed of the disease, being unable to grow through this substance; hence, the great importance of having the material upon the foliage and fruit before the disease starts.

Insects are destroyed by eating parts of plants upon which has been sprayed a little poison, or by having their bodies struck by some penetrating substance, such as oil.

The standard material to insure protection against fungous troubles is called Bordeaux mixture; the name "Bordeaux" was taken from the place in France where the mixture originated. It could just as well be called "Detroit," "Jackson," or "Charlevoix." There are but three things used in its preparation, water, lime and copper sulphate. The water acts as a carrier, the lime neutralizes the caustic action of the copper sulphate and also makes the mixture stick to whatever it is sprayed upon, and the copper sulphate is the chemical that prevents the growth of the spore of the disease.

These three substances are combined in various proportions, depending upon the kind of plant to be treated; but for apples, the one generally used is 50 gallons of water, 6 pounds of stone lime and 4 pounds of copper sulphate. Poison is added as needed. The copper sulphate will readily dissolve in 2 gallons of hot water, to which should be added enough water to make 25 gallons or one-half barrel. Slake the lime into a thin paste and add water to make 25 gallons. Pour these together and the Bordeaux is made. When it is emptied into the spray barrel or tank, it should be strained through a brass wire strainer to catch any of the coarse particles.

Whenever it is necessary to use a quantity of the mixture, it is desirable to have the lime and the copper sulphate in "stock solution." A quantity of lime is slaked to a paste and held so by being covered with water. The copper sulphate, say 50 pounds, is placed in a clean gunny sack and suspended in a barrel holding 25 gallons of water. This will dissolve in about a day. One gallon of this "stock solution"[1] is equal to 2 pounds of copper sulphate.



A good quick way to combine these three substances is as follows: Put the amount of the "stock solution" of copper sulphate required in a barrel, and add enough water to make 25 gallons, or one-half barrel. Put about 7 pounds of the lime paste in a barrel and add 25 gallons of water, making a thin whitewash. Pour, or let these two run together into a third barrel, or directly into the spray barrel or tank, being sure to strain. When partly run in, test with ferro-cyanide of potash[2] to make sure enough lime has been used. If Paris Green, arsenate of lead, or any other poison is to be used, make it into a thin paste with a little water and add it to the Bordeaux mixture, which is now ready to be used.

SPRAYING FOR SCALE.

San Jose scale must be cleaned out of the orchard, or it will ruin the trees in a few years.

Experience has demonstrated that the best method of treating scale-infested trees is to spray them in the spring before growth starts, with the lime and sulphur wash. This is made with 20 pounds of lump lime, 15 pounds of sulphur and 50 gallons of water. The lime and sulphur are placed in a cooking receptacle and 15 to 20 gallons of water added. Boil for about one hour, stirring frequently. Add water to make up the 50 gallons, strain through a fine, brass wire strainer into the spray tank, and apply while warm.

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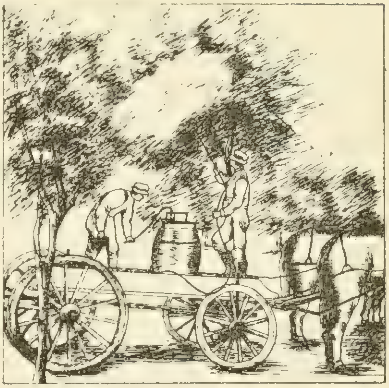
[1] Always stir this "stock solution" before dipping any out, that what is used may be of full strength.

[2] This chemical can be secured of any druggist. Ten cents worth dissolved in a pint of water will be enough for a season. Drop a very little in the Bordeaux, if a reddish, brown color appears, more lime must be added. If there is no discoloration, there is enough lime.

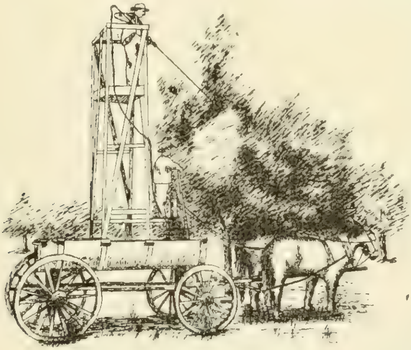
EQUIPMENT FOR SPRAYING ORCHARDS.



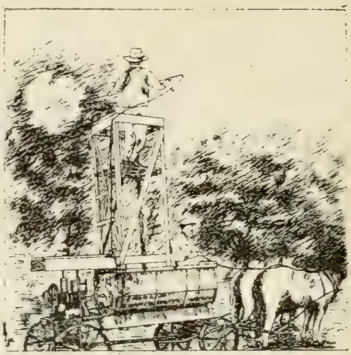
The equipment necessary for spraying orchards should depend upon the amount of work to be done, and herewith are briefly described the most common types.

A Barrel Outfit. A good strong pump and agitator adjusted in a barrel holding 50 gallons can be carried about in any kind of a wagon. One man can drive and pump, while the other attends to the spraying. Such an outfit is satisfactory for small orchards. It costs from $12 to $20.

A Tank Outfit with hand pump. A tank holding 100 or more gallons is set upon a wagon bed, and on the tank is fitted a pump, usually of greater power than a barrel pump. Generally a tower is built upon the tank from which the tops of good sized trees can be sprayed. One man can drive and pump, and one or two can spray. Some device to keep the mixture agitated should be provided. This is frequently driven by the sprocket gear attached to one of the wagon wheels. The man who pumps can give the mixture frequent agitation with a paddle or large wooden hoe. A tank holding about 200 gallons will cost about $10. The pump will cost about $25.

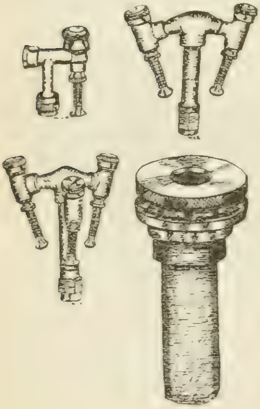


A Gas Power Outfit consists of a tank of 50 to 200 gallons capacity to hold the spray liquid, into which is fitted an agitator. An iron tube containing carbonic acid gas furnishes the power. The tubes of gas are purchased from manufacturers in cities or large towns, and when empty are returned. Their merits are lightness and saving power. Complete outfits can be purchased, including a steel wagon, tank with hand pump for filling, and steel tower for about $190.



A Gasoline Power Outfit. Gasoline engines for spraying have been greatly improved in recent years, and more are being used every season. Their use is economy for owners of large orchards and the engine can be used for various purposes on the farm. The engine is usually mounted on the rear of the wagon, and also runs the agitator; canvas curtains protect it from exposure. The tank is of any size desired and frequently a tower is built upon it. A complete outfit costs from about $175 up.

HOSE EXTENSION RODS AND NOZZLES.



With many spraying outfits and pumps, a certain number of feet of hose is included, but often more than this amount is desirable, especially if large trees are to be sprayed.

Extension rods connected with the discharge hose are used to reach the high branches and to put the spray where wanted, as into the interior of a tree. They are usually made of a length of brass or iron one-fourth or three-eighths inch pipe, fitted inside a bamboo rod, with a stop cock at the lower end, and a nozzle screwed on the top. They are usually 8 feet long.

Modern improvements of the old Vermorel nozzle,—and there are several,—are satisfactory. They give a fair spray with 50 pounds pressure, and better with more power.

TIME TO SPRAY APPLE ORCHARDS.

1st time. Just before the blossoms open. A poison. Paris Green, about one-fourth pound, or arsenate of lead about one and one-half pounds is added to the Bordeaux.

2nd time. Just after the blossoms fall, and again, it is desirable to use poison.

3rd time. About two weeks after the second application, and with poison.

4th time. Early in August. Experience has shown that this is a timely spraying to destroy the second brood of codling worms and check a late development of apple scab. Use only about one-half as much copper sulphate, but the same amount of poison, as in the other sprayings.

NOTES.

If you have to buy an outfit, send for catalogs of the different manufacturers. If your neighbor has an outfit, get the benefit of his experience.

Do a thorough job, squirting a little mixture on a limb is poor business. Drench the whole tree.

Let the wind help you. Spray with it, then finish the work when it is still, or blows from the opposite direction.

A leather pad fitted on the extension rod just above the hand affords some protection from the drip.

Bordeaux that has stood over night is not so good as freshly made mixture.

A little vinegar will easily and completely clean the hands from Bordeaux. A piece of pieplant stalk crushed in the hands will do the same thing.

Cover the horses with a canvas sheet.

PRELIMINARY REPORT ON WINTERING FARM WORK HORSES.

BY H. W. NORTON, JR.

Bulletin No. 254.

FOREWORD.

The economic wintering of the farm work horse has become an important problem. Oats and timothy hay are expensive feeds for the idle work horse. On the other hand horses wintered over in the barnyard on straw and cornstalks only, are not in condition to endure the severe farm labor upon the sudden opening up of work in the spring. This bulletin suggests the use of a variety of cheap substitute feeds. The large variety hereinafter given need not all be used, though the possibilities of their use are demonstrated. The publication may seem untimely, appearing at the close of winter, but it bears suggestions of preparation for the coming season. Do not neglect to produce and properly store some corn fodder, oat straw, mixed hay, roots, etc., for the horses during next winter. (By corn fodder is meant corn grown in drills thick enough to produce moderate sized stalks, an abundance of leaves, and from 1-2 to 2-3 of a crop of ear corn, the whole to be fed to the horse in bundle form. A small part of the corn field might be planted in this way.)

WINTERING FARM HORSES.

BY H. W. NORTON, JR.

On the average Michigan farm there is comparatively little work for horses during the winter months and this fact, together with the high prices of feed during the past few years, has made the standard horse ration of timothy hay and oats an expensive one. The following work has been done by the Farm Department with a view toward formulating more economical rations suitable to maintain horses in good flesh during the season of the year when work is light. This report is of a preliminary nature and more complete results will be reported after the experiment has been repeated.

Illustration 1.

In the trial, completed during the past winter, sixteen horses belonging to the college were under test throughout a period of ten weeks, from December 1st, 1907, to February 8th, 1908. Six horses, Nos. 1, 2, 3, 4, 5 and 6, owned by the Horticultural Department, were fed the regular ration of timothy hay and oats. Six horses, Nos. 7, 8, 9, 10, 11 and 12, owned by the Farm Department, were fed on a cheaper ration made up of shredded corn stalks, oat straw and hay for roughage, together with ear corn, oats, and a mixture of dried beet pulp, bran, and oil cake for concentrates and in addition a few carrots daily. The six horses, Nos. 7-12, were the regular farm teams and can be compared with the six Horticultural Department horses as they averaged nearly the same in weight and did about the same amount of work during the period, as the work-report given later will show. A better way would have been to divide the teams, feeding one horse of each team on the regular ration and the other on the cheap ration; that plan will probably be followed in the continuation of the work, but was impossible at the time. The remaining four horses, Nos. 13, 14, 15 and 16, were fed on the cheap ration the same as 7-12, but they were at rest a great part of the time and were not fed as heavily as the others. The feeding was all done by one man who kept records of all feed con sumed and all work done by each horse. The six horses, Nos. 1-6, belonging to the Horticultural Department, were fed by the same feeder but under the direction of the department teamsters. The horses were weighed at the beginning and at the close of the period, weights being taken at 10:30 a. m. and 4:00 p. m. of each day and the average of the two weights taken as the correct one.

Illustration 2.

THE HORSES.

The horses used were all in good condition and had been kept on the same ration until the beginning of the test. The six horses kept on the regular ration, Nos. 1-6, were twelve to thirteen hundred pound animals, averaging 1,254 pounds at the outset. This group is represented by four horses in illustration 1. They were used by the Horticultural Department for cleaning snow from the walks on the campus, hauling manure from Lansing to the college, a distance of three miles, and delivering coal at the college, in addition to other miscellaneous work. Nos. 7-12 were the regular farm teams used to haul feed from the city and manure from the barns to the fields. This group is represented by four horses in illustration 2. They were a little heavier than Nos. 1-6 and averaged 1,291 pounds at the beginning of the trial. The other four horses, Nos. 13-16, were worked comparatively little. Nos. 13 and 14 were a pair of light driving horses and were driven only enough for exercise. This pair is shown in illustration 3. Nos. 15 and 16 were old horses; No. 15 was worked considerably but No. 16 was idle most of the time. These last four horses cannot be compared with the other two lots as conditions were very different. Fair comparisons and conclusions can be drawn, however, from the results shown by Nos. 1-6 and 7-12, as they were kept under the same conditions.

Illustration 3.

THE RATIONS.

Regular Ration. Fed Nos. 1-6.

Oats	11-12 lbs. daily.
Timothy	18-20 lbs. daily.

Bran, a light feed once a week.

These six horses were fed by the regular feeder but under the directions of the teamsters. The oats were given in three feeds of about 4 lbs. each at 5 o'clock in the morning, at noon and at 5:30 at night. They were given a light feed of hay morning and noon and a heavier feed at night, or the noon feed was dropped out and the others increased accordingly. They consumed an average of 18-20 pounds of hay per day. One horse, No. 3, was fed only about 8 lbs. of oats, but ate from 30-35 lbs. of hay daily.

The Cheap Ration. Fed Nos. 7-16.

The remaining ten horses, 7-16, had been fed the same as the others but were changed to the cheaper ration one week before the start of the test and were fed this ration throughout the ten weeks of the feeding period. The ration consisted of shredded corn stalks, oat straw, hay, carrots, oats, ear corn and a feed mixture of dried beet pulp, bran and oil cake in the proportion of:

Dried beet pulp	4 lbs.
Bran	1 lb.
Oil cake	1 lb.

The ration was fed as follows to Nos. 7-12:

Morning feed:

Oat straw	5 lbs.
Carrots	4 lbs.
Ear corn	3 lbs.

Noon feed:

Timothy hay	4 lbs.
Oats	2 lbs.

Night feed:

Shredded corn stalks	8 lbs.
Carrots	4 lbs.
Feed mixture	2 lbs.

Nos. 13-16 received the same ration in smaller quantities, averaging only a little over one pound of oats daily.

In feeding these substitute feeds it was thought best to provide a variety, as none were as palatable as the regular hay and oats ration. The stalks and oat straw were eaten fairly well after the first few days. The carrots seemed to be relished by all the horses but No. 14 which was the poorest feeder of all. The feed mixture of beet pulp, bran and oil cake was eaten well in most cases; sometimes, however, the oil cake was left.

SCALE OF PRICES.

The regular scale of prices which has been used at this station was utilized in figuring costs of rations, as a regular standard is necessary for comparisons from year to year. Because of abnormally high prices existing throughout the past year, results are also figured on the basis of current market prices.

	Established scale of prices, per ton.	*Current prices, per ton.*
Corn stalks	$2.50	$4.00
Oat straw	3.00	5.00
Carrots	2.00	3.00
Timothy hay	8.00	12.00
Ear corn	14.20	20.00
Oats	20.00	31.00
Wheat bran	18.00	24.00
Dried beet pulp	15.00	18.00
Old process oil cake	28.00	30.00
Dried beet pulp 4 lbs. Bran 1 lb. Oil cake 1 lb.	Feed mixture, $17.66 per ton	21.00

The tables of cost hereafter given show figures according to both of the above lists of prices.

Feed consumed 10 weeks (Dec. 1-Feb. 8) Nos. 1-6 fed regular ration.

No.	Timothy hay, lbs.	Oats, lbs.	Bran, lbs.	Total cost, old scale of prices.	Average daily cost, cents.	Total cost at current prices.	Average daily cost, cents.
1	1,322	811	17.5	$14 26	20.4	$21 79	31.1
2	1,322	877	17.5	14 22	20.2	21 73	31.0
3	2,016	541	17.5	13 63	19.5	20 70	29.6
4	1,294	722	17.5	12 56	17.9	19 16	27.4
5	1,317	793	17.5	13 36	19.1	20 40	29.1
6	1,317	800	17.5	13 43	19.2	20 51	29.3
Average	1,431	769	17.5	$13 58	19.4.	$20 72	29.6
Average per day	20.4	11.0	....	0.194	19.4	0.296	29.6

The above table shows that the six horses fed the regular ration consumed, on an average, 11.0 lbs. oats and 20.4 lbs. timothy hay daily, during the ten weeks of the trial. The average weight Dec. 1st was 1,254 lbs., and Feb. 8th was 1,243 lbs., a loss of 11.0 lbs., showing that the weight was not quite maintained.

Feed consumed, ten weeks, Dec. 1st-Feb. 8th, Nos. 7-12, fed cheaper ration.

No.	Corn stalks, lbs.	Oat straw, lbs.	Carrots, lbs.	Hay, lbs.	Oats, lbs.	Ear corn, lbs.	Feed mixture, lbs.	Cost at old prices.	Cost per day, cents.	Cost current prices.	Cost per day, cents.
7............	622	302	373	296	210	289	180	$8 52	12.2	$12 38	17.7
8............	579	302	371	296	210	291	180	8 48	12.1	12 32	17.6
9............	605	302	377	300	264	305	180	9 19	13.1	13 36	17.7
10............	605	302	377	300	210	291	179	8 54	12.2	12 38	17.7
11............	602	302	377	296	211	279	186	8 49	12.1	12 32	17.6
12............	597	302	377	296	211	289	186	8 56	12.2	12 41	17.7
Average.......	602	302	375	297	219	291	182	$8 63	12.3	$12 53	17.7
Av. per day....	8.6	4.3	5.4	4.2	3.1	4.2	2.6	0.123	12.3	0.177	17.7

At the start of the feeding period no oat straw was available and a larger amount of corn stalks was fed. The average consumption daily, for each of the six horses, was 8.6 lbs. corn stalks, 4.3 lbs. oat straw, 5.4 lbs. carrots, 4.2 lbs. timothy hay, 3.1 lbs. oats, 4.2 lbs. ear corn and 2.6 lbs. of the mixture of beet pulp, bran and oil cake. The horses averaged 1,291 lbs. December 1st and 1,305 lbs. February 8th, showing a slight gain of 14 lbs. each during the ten weeks.

A comparison of these two tables will show that Nos. 1-6 were fed at an average cost, by the old scale of prices, of 19.4 cents per day, while Nos. 7-12 were fed on a cheaper ration at a cost of only 12.3 cents per day, a difference of 7.1 cents per horse daily in favor of the cheaper ration. The regular weights show also that the horses on the cheaper ration were maintained in slightly better flesh, as they gained 14 lbs. each during the ten weeks, while the others lost 11 lbs. each during the same period. Or, figuring on a basis of current market prices, it cost 29.6 cents per day to feed the regular ration as compared to 17.7 cents when the cheaper ration was fed, a saving of 11.9 cents per horse daily, when the cheaper ration was used. This would amount to 83.3 cents per week for each horse and would be a considerable item where a number of horses were being kept, besides utilizing a class of roughage which is of little value on the market.

Feed consumed in 10 weeks, Dec. 1st-Feb. 8th, Nos. 13-16 fed cheap ration.

No.	Corn stalks, lbs.	Oat straw, lbs.	Roots, lbs.	Hay, lbs.	Oats, lbs.	Ear corn, lbs.	Feed mixture, lbs.	Cost at old prices.	Cost per day, cents.	Cost current prices.	Cost per day, cents.
13............	474	167	381	350	82	279	150	$6 74	9.6	$9 68	13.8
14............	523	292	325	245	82	218	138	5 92	8.5	8 64	12.3
15............	537	302	381	278	82	213	150	6 26	8.9	9 05	12.9
16............	537	302	380	259	68	224	137	6 02	8.6	8 68	12.4
Average.......	518	266	367	283	79	234	144	$6 24	8.9	$9 01	12.9
Av. per day....	7.4	3.8	5.2	4.0	1.1	3.3	2.1	0.089	8.9	0.129	12.9

These horses were lighter than the others, averaging 1,123 lbs. and were idle a large part of the time, so were fed much less than Nos. 7-12. The cost was 8.9 cents per horse daily, or 12.9 cents according to current market prices. They averaged 1,123 lbs. at the beginning and 1,119 lbs. at the close, so were practically maintained at weight, losing but 4 lbs. during the 10 weeks.

WEIGHTS.

	Dec. 1st, 1907.	Feb. 8th, 1908.	
Average, Nos. 1- 6	1,254	1,243.	Loss 11 lbs.
Average, Nos. 7-12	1,291	1,305.	Gain 14 lbs.
Average, Nos. 13-16	1,123	1,119.	Loss 4 lbs.

The differences in the weights of the three lots from the beginning of the feeding trial, Dec. 1st, to the close, Feb. 8th, are so small that they can be overlooked and the horses said to have been maintained at steady weight.

Days worked during 10 weeks, (70 days).

	Lot 1-6.	Lot 7-12.	Lot 13-16.
Average	47 days.	41.5 days.	27 days.

This table shows that lot 1-6 worked 47 days against 41.5 days by lot 7-12, a difference of 5½ days for each horse during the ten weeks. This difference in amount of work done, while not great, would have some bearing on the experiment, but the difference would probably be very slight. The other four horses, lot 13-16, did a much smaller amount of work and are not comparable, but the results are given rather to show the cost of feeding where the horses were at rest the greater part of the time.

AVERAGE COST PER HEAD DAILY.

	Cost at old scale of prices—cents.	Cost at current prices—cents.
Nos. 1-6 receiving the regular ration—hay and oats	19.4	29.0
Nos. 7-12 receiving the cheaper ration.	12.3	17.7
Nos. 13-16 receiving the cheaper ration.	8.9	12.9

The above table shows that during the feeding period of ten weeks, the six horses in lot 7-12 were fed for 17.7 cents per head daily as against 29.6 cents per head for lot 1-6 fed the regular ration, a difference of 11.9 cents per head daily in favor of the cheaper ration. For the ten weeks of the test period it cost at current market prices, $124.29 to feed six horses, Nos. 1-6, on the ration of hay and oats. During the same period the total cost for the six horses, Nos. 7-12, was $75.17, a saving of $49.12 on the six head or $8.18 per head for the ten weeks.

CEMENT SILOS IN MICHIGAN.

Bulletin No. 255.

BY J. A. JEFFERY.

The number of silos in Michigan is steadily increasing. The importance of silage as a feed is coming to be more fully and more extensively appreciated. In a similar ratio there is an increasing demand for information concerning silo construction and silo material and this demand has led to the publication of this bulletin.

The plan followed in the preparation of this bulletin is:

1st, To include some of the more important well established theories of silo construction and

2nd, To present a number of illustrations of successful Michigan silos with data as to materials used and, where possible, methods of construction and labor required.

Ensilage may be roughly defined as moderately fermented succulent feeding material. The succulent material is usually green corn in this country. Other materials sometimes used are green field peas, cow peas, soy beans, horse beans, ensiled alone or with corn. Green rye, wheat, oats and others of the grasses are sometimes used.

Some practical ensilage users think that certain of the legumes, such as alfalfa, clover, field peas, cow peas or soy beans mixed with corn make a much more desirable ensilage than does corn alone. Three reasons are offered for this preference:

1. Stock enjoy this mixed ensilage better.
2. Stock thrive better upon it.
3. Such an ensilage approaches more nearly a balanced ration.

The green material is nearly always cut into short lengths before being put into the silo. For several reasons it is better to cut it, but it is not imperative that it be so cut. In early practice not even corn was cut in ensiling.

The best ensilage is produced when the air can be kept most completely from coming in contact with the ensiled material.

A silo may be defined as a deep chamber with air tight wall, in which green fodders are preserved in a mildly fermented condition for future feeding.

ESSENTIAL QUALITIES OF A GOOD SILO.

1. The wall should be perfectly air tight; otherwise air will get into the ensilage and promote molding and rotting.

2. The inner surface of the wall should be perpendicular and smooth. Where these qualities are lacking, open spaces are almost sure to occur between the ensilage and the wall of the silo as the ensilage settles. The air will work into these spaces with the effects mentioned above.

3. The walls should be strong and rigid. If they do not possess

these qualities they will crack or spring and air will be admitted to effect the spoiling of the ensilage.

4. The walls should be sufficiently nonconducting ("warm") to prevent extensive freezing of the outer portions of the ensilage in cold weather. Such portions as adhere to the walls by freezing are likely to spoil if they thaw out slowly.

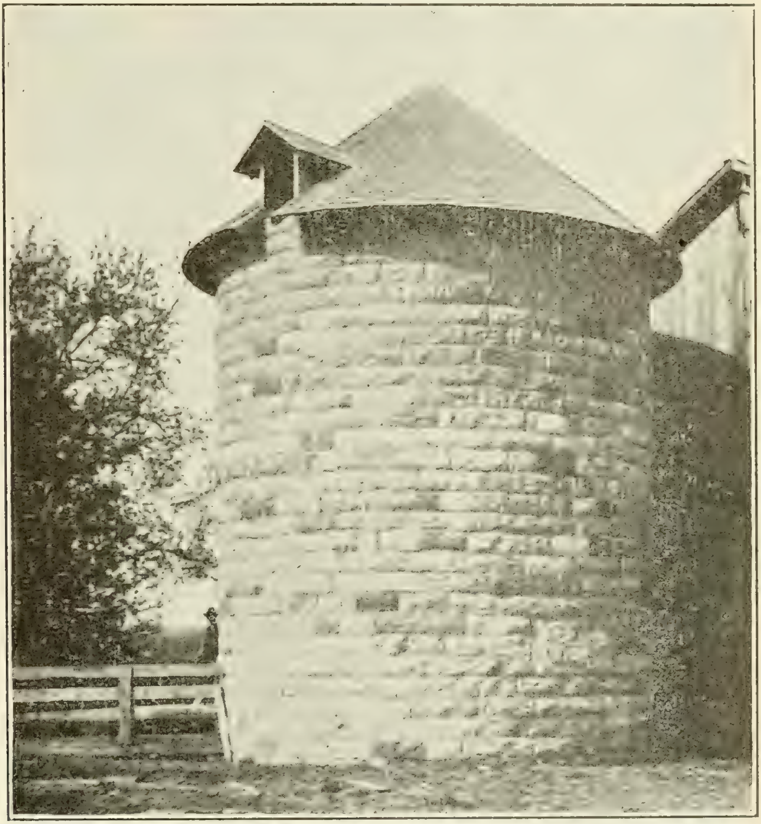


Fig. 1. Silo owned by W. E. Arnold, Jamestown, Mich. Built in 1901 of field stone. Height 30 ft. Diameter 16 ft. Walls 18 inches thick.

It has been found that considerable losses from excessive fermentation may take place because of defective walls and still the ensilage may appear reasonably good and may be relished by the animals to which it is fed.

SILO TYPES AND MATERIALS.

There are two general types of silos: viz., the *square* and the *round,* with some intervening modifications.

The early silos were mostly, if not all, of the square type. They were made chiefly of wood in this country. Square silos are seldom made now; when made of wood it is not easy to make the walls sufficiently rigid to be entirely satisfactory. Built of stone, brick or cement, the walls may be made sufficiently strong to produce a perfect ensilage. On the farm of Mr. H. F. Probert, Jackson, Mich., there are four splendid square silos, built of vitrified brick, which have been in use for several years.

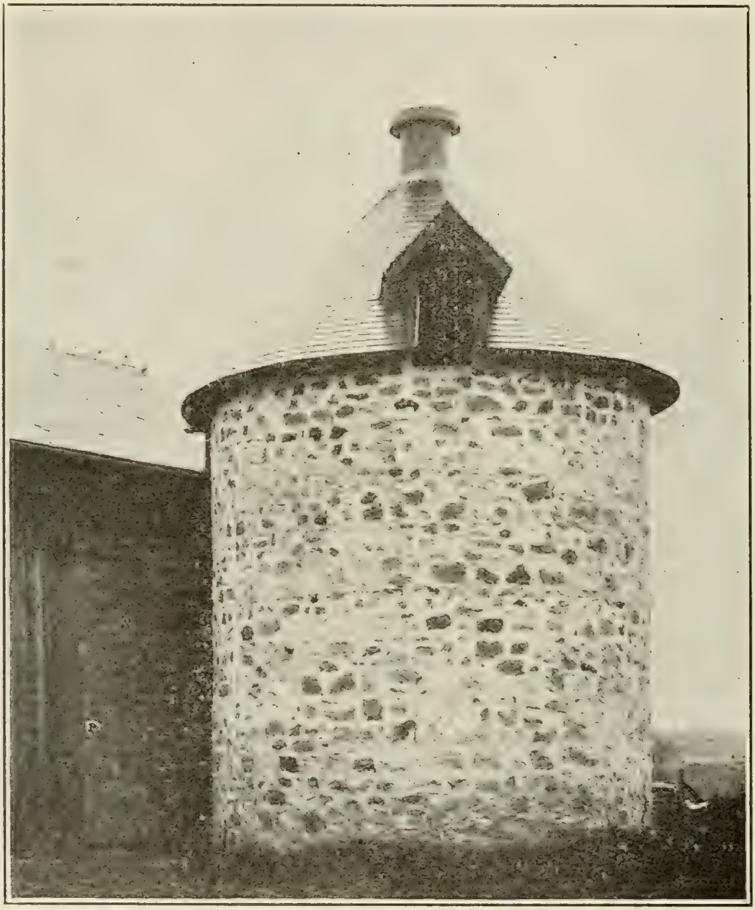


Fig. 2. Silo located on the H. P. Deering farm west of Jackson. Built of common field stone, 1902. Height of wall 26 ft. Inside diameter 16 ft. Thickness of wall 18 inches. Floor 7 feet below ground.

The round silo is the popular type. It is found built of wood, stone, brick and cement and of various combinations of these materials. See Figs. 1 and 2.

Two general styles of wood construction are found:—The so-called "all wood" and the stave. A description of the "all wood" construction will be found on page 63 of bulletin No. 250 of this station. Few "all wood" silos are now built in this state, especially in the lower peninsula.

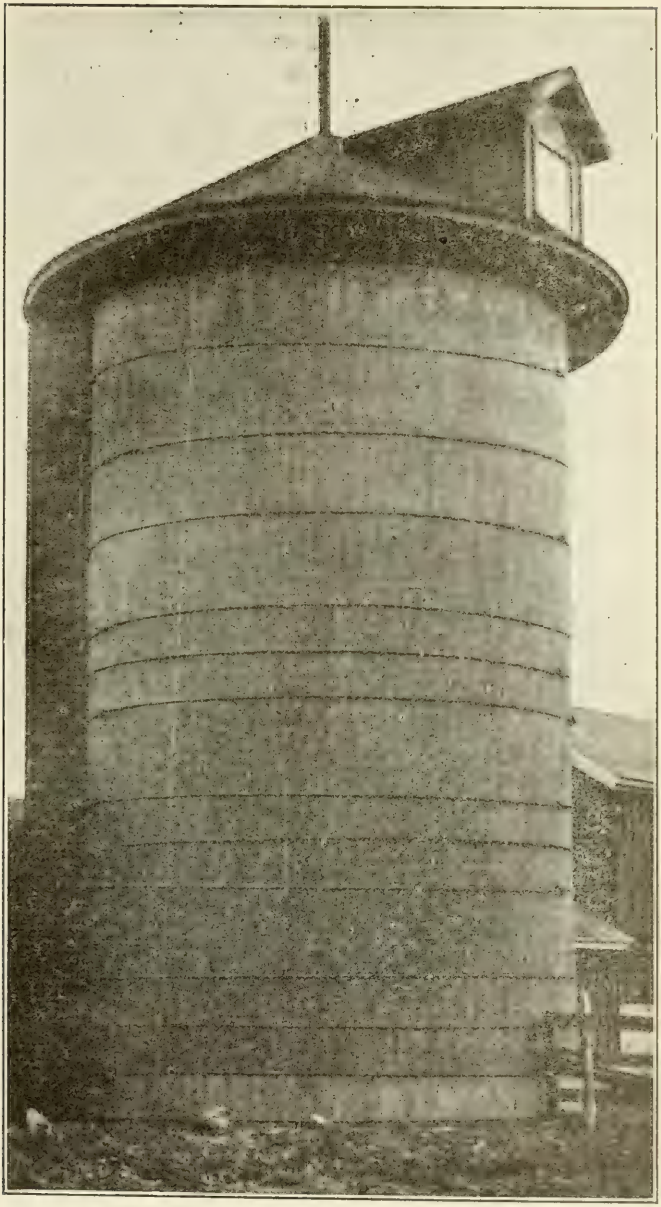


Fig. 3. Typical stave silo.

During the past ten years by far the greater number of silos built in the state have been stave silos. See Fig. 3. During the same period the growing scarcity of certain kinds of wood and the increasing prices of all kinds of wood have directed the attention of farmers to the use of other materials in silo construction.

Little need be said concerning the stave silo. The number of these silos erected annually and the general satisfaction expressed by the owners are indications of their efficiency. In some cases the farmer purchases his own materials and constructs the silo himself, but he generally buys the ready made silo and in view of the growing scarcity of lumber and the difficulty of procuring proper material at the general lumber yard, the latter way would appear to be the most advisable. There are a number of reliable firms manufacturing stave silos.

Suggestions may be offered at this point:

However open the cracks between staves may be while the silo is empty, these cracks should be closed when the silo is filled. Otherwise losses must occur because of penetration of air through the cracks into the ensilage. Hence the importance of intelligent tightening of the hoops.

Every unsound stave should be rejected when selecting lumber with which to build a stave silo or in purchasing a ready made one. Sapwood and worm eaten pieces are unfit for silo construction. The writer recently inspected the staves of a silo, erected seven years ago, which was being moved to a new foundation. One stave, defective as indicated above, was too badly rotted to be of further use. The other staves were in a good state of preservation except for some rotting at the lower ends which rested on the foundation. Staves of silos rot most rapidly at the lower end,—where they come in contact with the foundation. If before setting up, the lower six or eight inches of the staves could be thoroughly treated with warm coal tar or, better perhaps with carbolineum, their durability would be considerably increased.

For several years past there has been a growing interest in cement as a material for silo construction. Silos of cement have been constructed in several parts of the state. Reports concerning their efficiency have been conflicting, and numerous theories have been set forth as to why they should or should not produce good ensilage. Numerous questions come to us concerning the possibilities of cement silos, materials required, methods of construction, etc.

While there is much more to learn concerning cement silos and cement silo construction, it has been proven that durable efficient silos can be made and are being made of cement. Such silos are in use and possess all of the essential qualities named on page 236.

Below are given descriptions of seven cement silos in use in different parts of the state.

THE BOARDMAN SILO.

So far as the writer knows the first cement silo in the state was erected on the farm of J. W. Boardman, which is upon the Clinton Road, northwest of and a short distance from the city limits of Jackson. See Fig. 4. This silo is of the solid wall kind and was built in the summer of 1902. It is now seven years old and has been filled seven times. The inside diameter is 16 feet. The height of wall above floor is 24 feet. The lower sixteen feet of the wall ranges from a little more than 8 inches below ground to 8 inches above ground. The upper

8 feet of wall is 6 inches thick. The floor is 5 feet below the sill of the lower door and is nearly that much below ground on the barn side.

There are four doorways, 54 inches apart, sill to sill, which carry doors 24 inches high by 22 inches wide. The two lower door frames are made of a single thickness of 2 inch by 8 inch material; the two upper frames are made of a single thickness of 2x6 material. All the frames are built into the wall and all have jambs of lath.

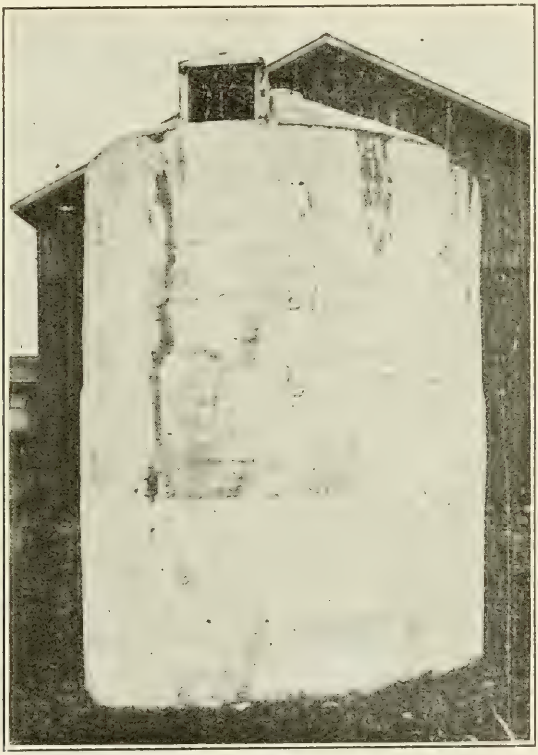


Fig. 4. The Boardman solid wall cement silo built in 1902, near Jackson, Mich.

The doors are made of a single thickness of inch material. When filling the silo the doors are set in place, a piece of galvanized sheet iron 26 inches by 28 inches is placed against the inside of each and tacked to the door frame and the ensilage material is filled in against the sheet iron. The sheet iron thus lapping two inches beyond the edges and ends of the doors is held tightly against the door frame and prevents the air from reaching the silage by way of the doorways.

For the roof, rafters are placed two feet apart on the wall. A dormer window was built as shown in Fig. 4, about 2 feet by 2 feet. A galvanized iron round ventilator 1 ft. in diameter and 4 inches high was set at the peak. The ventilator has a roof of the same materials supported by 8 inch pieces of strap iron. As soon as the dormer and the ventilator were in place, lath was nailed to the upper edges of the rafters and dormer frame in the same manner as for ordinary plastering and upon the lath was spread a rich mortar of cement and sand mixed in the proportion of one to two.

The wall shows a great deal of weather checking, but this does not seem to affect the quality of the ensilage. In other words the checking does not extend through the wall and therefore does not allow air to penetrate to the ensilage.

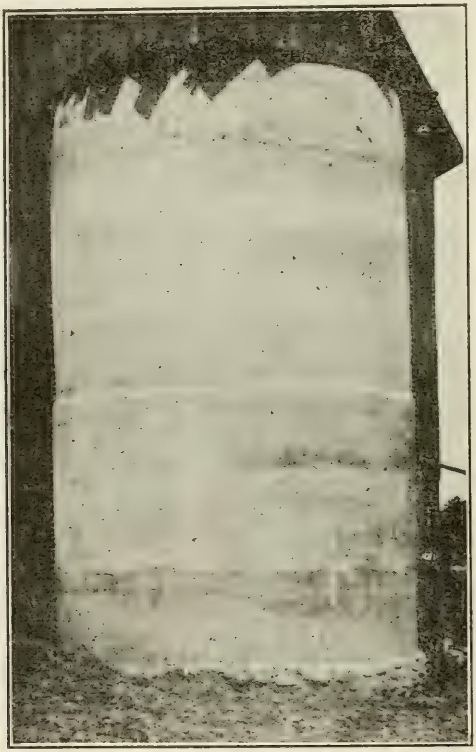


Fig. 5. Solid wall cement silo owned by W. L. Smith, East Lansing, Mich.

The owner, J. B. Boardman, has always expressed great satisfaction with the results obtained from the silo. It was built by Callam & Clark, of Jackson, and cost $250.00.

THE SMITH SILO.

A very interesting solid wall cement silo is one owned by W. L. Smith, who lives about one mile northwest of the college. It was built in the summer of 1904 and has been filled five times. This silo has an inside diameter of 14 feet and a total height of wall above floor of 30 feet including 6 feet of cobblestone-cement foundation. The floor stands 5 feet below ground. The foundation wall is 12 inches thick and extends 6 inches below the floor. The lower 12 feet of the cement wall is 10 inches thick. The upper 12 feet is 8 inches thick. Fig. 5 is from a photograph taken nearly four years after the completion of the silo and shows the walls to be remarkably free from checking of any kind.

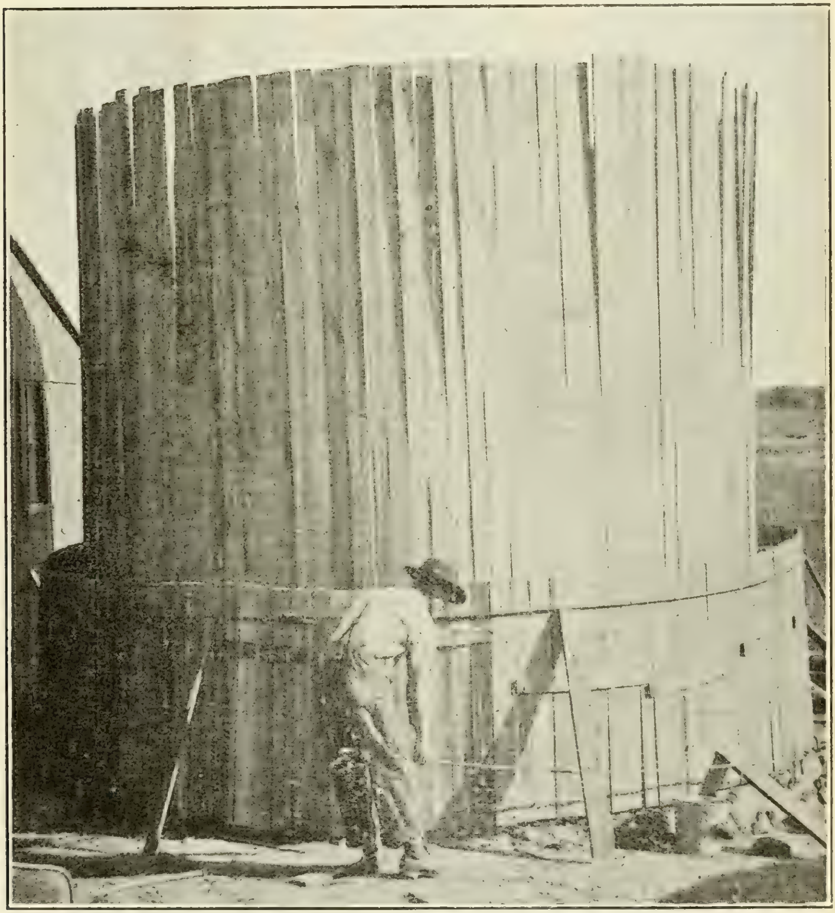


Fig. 6. Setting up the forms for the construction of the silo shown in Fig. 5.

The quality of the ensilage produced in this silo is very satisfactory to Mr. Smith. Samples of the silage have been examined by the writer and pronounced very good.

The doors of the silo, four in number, are 24 inches by 36 inches. They are especially well made of two thicknesses of lumber, with beveled edges, refrigerator style and fit snugly into equally well made frames, which in turn are built into the walls. The doors are set into the frames from the inside and are held in place by the silage.

After the construction of the walls they received an application outside and inside of a rich cement wash. The inner face of the foundation received a half coat of rich cement plaster.

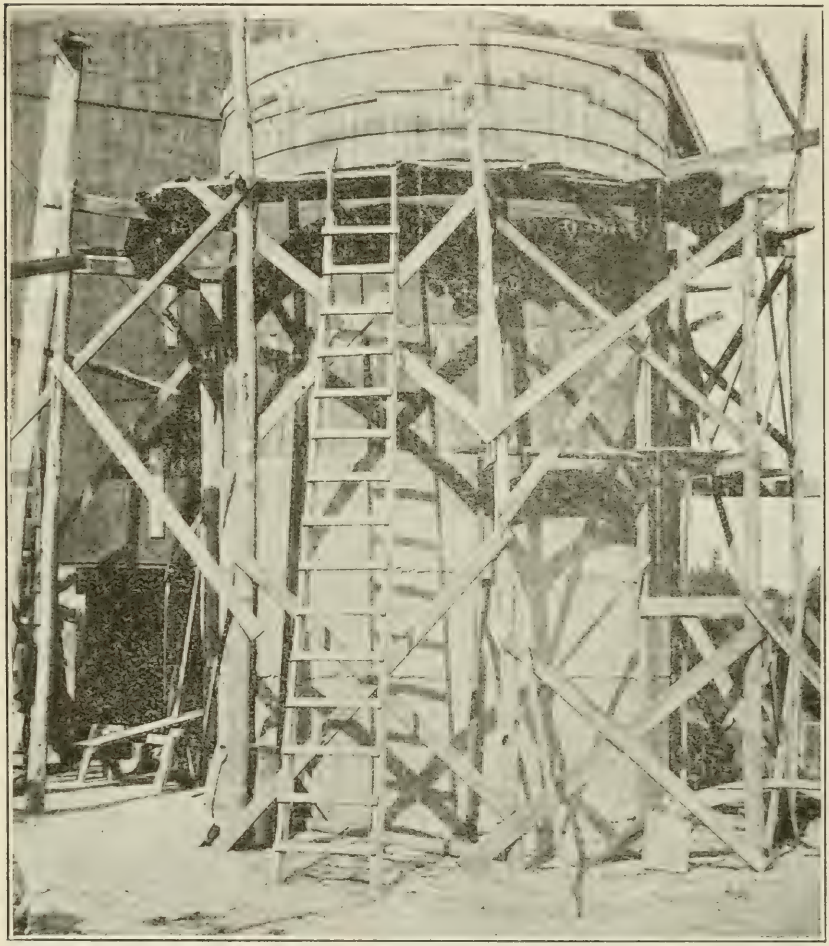


Fig. 7. Scaffolding and outer form as they appeared near the completion of the silo shown in Fig. 5.

Materials:

In the construction of this silo there were used:

30 barrels cement,
35 cubic yards sand,
$1\frac{1}{2}$ cords stone,
1 bale barbed fence wire for reinforcing the walls.

For forms there were used:
1100 feet lumber 7/8 inch x 4 inch x 16 feet,
4 hoops 1/2 round iron with lugs,
30 pounds nails.

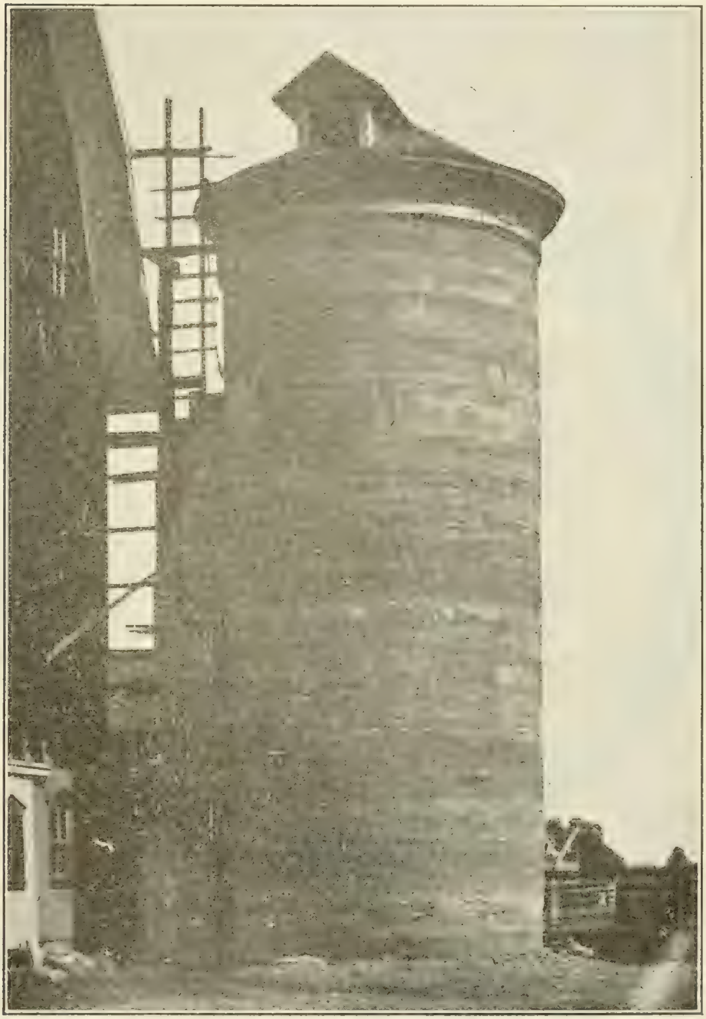


Fig. 8. Cement silo built and owned by L. A. Porter, Adrian, Mich.

A total of 31 days of labor was expended upon the construction. It would require considerably less labor for the same parties to build another silo of the same size after having acquired more experience.

A study of Figs. 6 and 7 will give the reader a fair idea of the kind of forms used and the manner of using them. The inner form was 16 feet high and had to be moved but once. The outer form was 4 feet high and was lifted nearly 4 feet each time it was moved. It was clamped to place by means of the hoops and lugs mentioned above and shown in Figs. 6 and 7.

Two strands of barbed wire were built into the concrete every 18 inches in the lower wall, as the forms were filled, and less frequently as the building of the wall progressed.

The proportion of cement and gravelly sand in the concrete of the wall is 1 to 7.

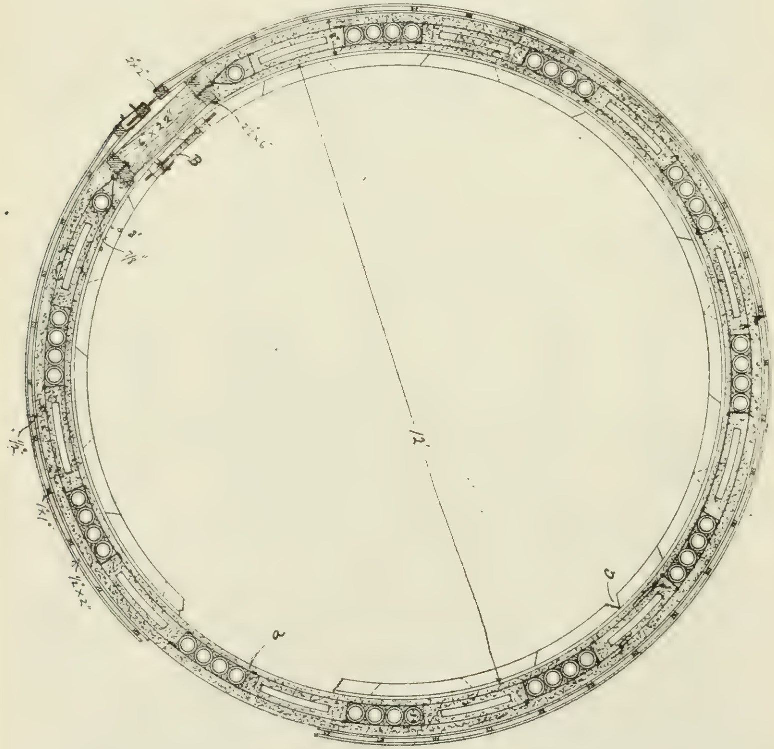


Fig. 9. Cross-section of wall and forms of Porter silo. A. Section of wall showing position of one of the reinforcing cables. B. Inner form and clamp used to spread it to place.

Mr. Smith has never placed a roof on this silo; 1st, because he has never thought a roof necessary (there are a number of roofless silos in the state) and 2nd, in filling the silo Mr. Smith stretches a piece of wire netting above the top of the silo and is thus able to pile up an extra 4 feet of ensilage material above the top of the silo, which in a short time settles within the walls proper of the silo.

Little freezing occurs next to the wall in this silo.

THE L. A. PORTER SILO.

Fig. 8 shows a view of the hollow walled cement silo of L. A. Porter, Adrian, Mich. It has an inside diameter of 12 feet and stands 36 feet high above the floor. The floor stands 4½ feet below the surface of the ground and 6 inches above the bottom of the foundation.

The lower 3 feet of the foundation is of cobble-stone and cement. The upper 2 feet is of concrete. The foundation is 10½ inches wide at the top and broadens inward and outward to about 17 inches at the base, the floor having a diameter of only 11 feet. The silo wall above ground has a uniform thickness of 8 inches and is unique in its construction.

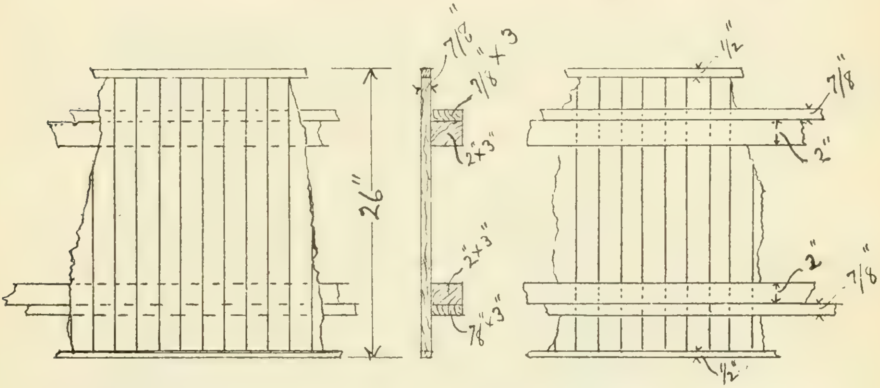


Fig. 10. Outer elevation, section, and inner elevation of inner form used in the construction of the Porter silo (Fig. 8.)

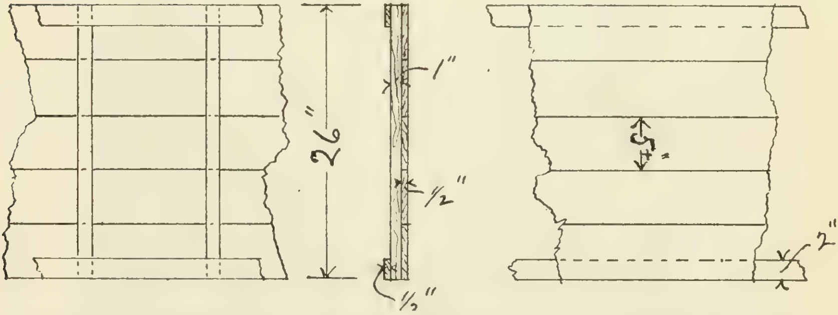


Fig. 11. Outer elevation, section, and inner elevation of outer form used in the construction of Porter silo (Fig. 8).

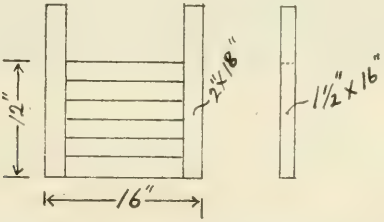


Fig. 12. Form used to make hollow in the construction of the wall of the Porter silo (Fig. 8).

Forms are used in its construction, but the wall is rendered "hollow"; first, by the use of forms and 2nd, by the building into the wall of tiers of No. 2 3-inch drain tiles. Fig. 9 represents a horizontal cross-section of the wall. It shows not only the arrangement of the tile and other hollow spaces but also the outer and inner forms, the plan of the door frame, and the manner of reinforcing the walls with the wire cables. The hollow spaces formed by the tile and by the forms are continuous. The tiles begin six feet above the foundation, form spaces lying below the tile. The form-spaces are continuous from foundation to top of wall. The inner form (see Figs. 9 and 10) was built of 2 inch by ⅞ inch by 26 inch pieces of pine, nailed upon two circles of elm. Each of these circles was built up of 2 inch by 3 inch pieces, breaking joints with ⅞ inch by 3 inch pieces. All of these pieces were cut to circles of proper radius.

The outer form (see Figs. 9 and 11) was built of 5 inch x ½ inch sheeting tacked to perpendicular ribs 1 inch x 1 inch, placed 1 foot apart. This form is reinforced by 2 inch x ½ inch strips nailed outside and at the ends of the ribs. These forms were clamped into place by means of two ½ inch bolts in each form as shown in Fig. 9.

The frame for a continuous doorway (Fig. 9) is made of 2½ inch x 6 inch oak bridge timber with a 1 inch x 1½ inch strip on the inner edge against the cement, which strip acts also as a shoulder for the doors. An inch strip on the outside of the 6 inch piece makes the thickness of the door frame equal to the thickness of the wall. Cross pieces of the same 2½ inch materials are set in the frame three feet apart, center to center. The inside width of the frame is 22 inches. The frame thus constructed was set up so that the sill stood one foot above the foundation, properly braced, and so was built into place.

For reinforcement, wire cables were built into the wall at intervals of 18 inches. The manner of stretching the cables is shown in Fig. 9. In the lower wall, four No. 7 wires were twisted together for this purpose; in the upper wall, two No. 7 or No. 9 wires were twisted together.

Fig. 13 shows the scaffolding and forms used in the construction of the silo. Four posts were set up at quarters about the silo. The opposite posts were tied (nailed) together by cross or tie beams. From these cross beams were suspended the forms (outer and inner) by chains or wires.

To lift a form, four wire fence stretchers were wired or chained to the cross beams, one near each post. Chains fastened to the form were clutched by the stretchers and drawn tight. The form was then unclamped and lifted to the proper height by the use of the stretchers. This was usually done by placing a man or a boy at each stretcher and having all work in unison. Or if one man did the lifting, he passed from stretcher to stretcher, in order, giving to each one or two strokes. When the form was raised to the proper height, usually 24 inches, it was suspended by chain or wire to the cross-beams and properly clamped. The outer form should be clamped first always, because the clamping of the inner form into place before the outer form was so clamped would be likely to crack the unseasoned wall. The inner form supported the platform upon which the men worked.

The materials, gravelly sand and cement, were mixed in the proportions 5 to 1, in the usual way, excepting that the mixture was, perhaps, wetter than usual.

Upon the completion of the wall a 1/4 inch coat of plaster was applied to the inside. This plaster was made of sifted sand and cement in the proportions of two to one.

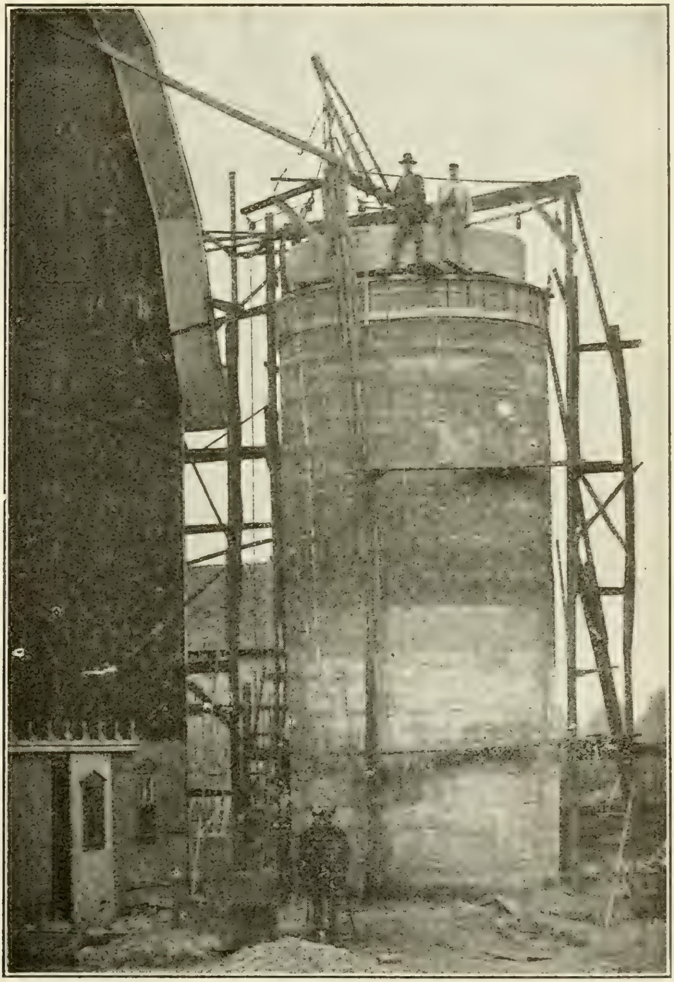


Fig. 13. Scaffolding and forms used in the construction of the Porter silo (Fig. 8) just before the completion of the silo wall.

This silo, built in the fall of 1907, has been filled twice and Mr. Porter is well pleased with the quality of the ensilage. Samples taken from the edge, center, and mid-way between center and wall and sent to the college were of good quality.

Materials used:

- 40 barrels of cement,
- 40 cubic yards of sand,
- 400 pounds of wire.

For the inner form, there were used in addition to sawed circles, about 95 board feet $\frac{7}{8}$ inch x 2 inch material and 75 linear feet $\frac{1}{2}$ inch x $\frac{7}{8}$ inch strips for upper and lower edges and $2\frac{1}{2}$ feet of 2 x 4.

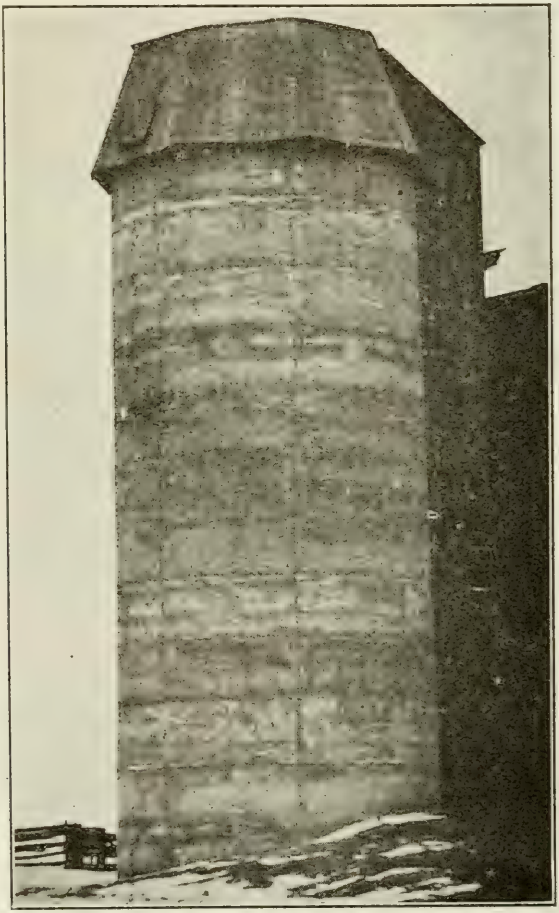


Fig. 14. Silo owned by Martin Gould, Brown City, Mich.

For the outer form, there were used about 115 board feet $\frac{1}{2}$ inch x 6 inch sheeting, 80 linear feet $\frac{1}{2}$ inch x 2 inch strips and 84 linear feet 1 inch x 1 inch material for ribs and $2\frac{1}{2}$ feet of 2 x 4.

In addition to the above there had to be provided material for scaffolding and platform and a few other sundries

The doors are of 1 inch material.

THE MARTIN GOULD SILO.

In the vicinity of Brown City there are six solid wall cement silos owned by as many different farmers but all built by Jacob Witmer of Brown City. In their construction steel forms were used. A brief description will be of interest.

Fig. 14 offers a view of one of these silos which is owned by Martin Gould, who resides three miles northwest of Brown City. It was built in the summer of 1908, has an inside diameter of 12 feet 2 inches and the wall stands 35 feet high, 5 feet of it below the ground. The wall is 12 inches thick at the base and 5 inches thick at the top. The inner surface of the wall is kept perpendicular, the outer surface tapers inward toward the top because of the gradual contracting of the outer form. The floor and wall rest upon the hard clay bottom of the 5 feet 8 inch excavation.

The doorways, of which there are six, are 20 inches x 28 inches. There are no door frames. The doors, made of two thicknesses of matched pine, are carried in shoulders moulded in the doorways at the time of building and just deep enough to receive the doors. To exclude the air an inch piece of felt is placed between the edge of the door and the shoulder in the doorway.

The proportion of cement to sandy gravel in the wall is 1 to 7. The wall was reinforced by laying in No. 9 wire every 12 inches.

The floor is 8 inches thick, was laid very wet and without tamping. The proportion of cement to sandy gravel being 1 to 8.

The inner surface of the wall was not plastered but instead was thoroughly washed with a good cement wash, as was also the floor.

The plate, built of 2 x 8 material and held in place by ½ inch x 8 inch bolts imbedded in the wall, carries the roof. The rafters, eight in number, are constructed upon the self-supporting plan. The lower section of the rafter is 5 feet 5 inches long. The upper section is 5 feet 4 inches long. The rafters in place meet at the center and are covered with ⅞ inch sheeting, which in turn is covered with rubberoid.

In the lower section of the roof (see Fig. 14) is seen a door, 18 inches x 20 inches, through which silage material is introduced.

The materials used in the construction of this silo are as follows:

37	barrels of cement,
52	cubic yards (35 loads) of sand,
100	pounds of No. 9 wire,
3	pieces 2x8x14 feet, for plates,
8	pieces 2x4x12 feet, for rafters,
280	feet sheeting for roof,
2	rolls rubberoid.

The labor expended in the work is estimated as follows:

36 days (4 men, 9 days) excavating and cement work.
7 days (2 men, 3½ days) building roof and doors.
3 days, horse to operate mixing machine.

This does not include hauling of sand and other material.

Total estimated cost of this silo, $202.00.

Fig. 15 shows the outfit used in the construction of this silo. It is owned by the Concrete Building and Construction Company of Brown City. A similar outfit is owned by M. G. Burbank of Eau Claire, Mich.

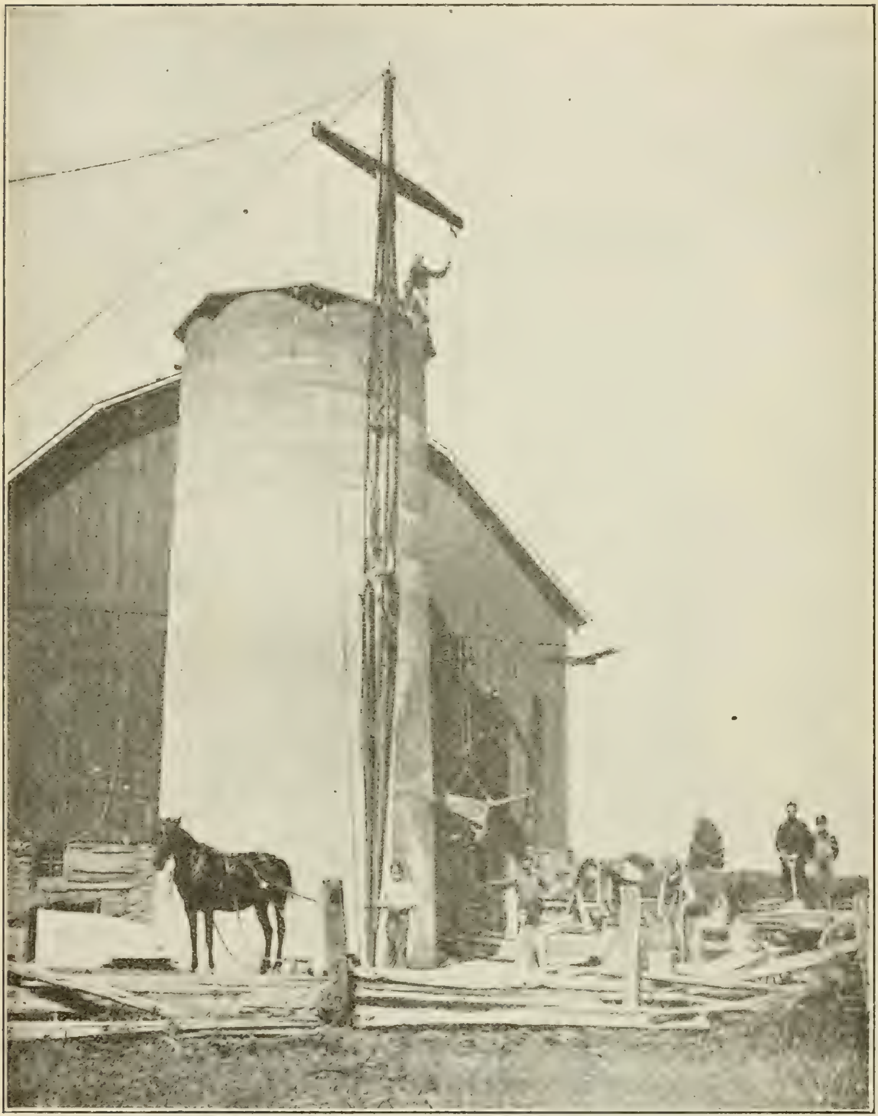


Fig. 15. Outfit used in the construction of the Martin Gould silo. (Fig. 14).

See description of college solid cement wall silo, page 66, Bulletin No. 250.

CEMENT BLOCK SILOS.

One of the earliest cement block silos erected in the state was built in 1904 on the farm of Fred Weeks, Richmond, Mich. See Fig. 16. The inside diameter of this silo is 16½ feet and the height of cement block wall is 28 feet. The blocks all have a face of 9 inches by 36

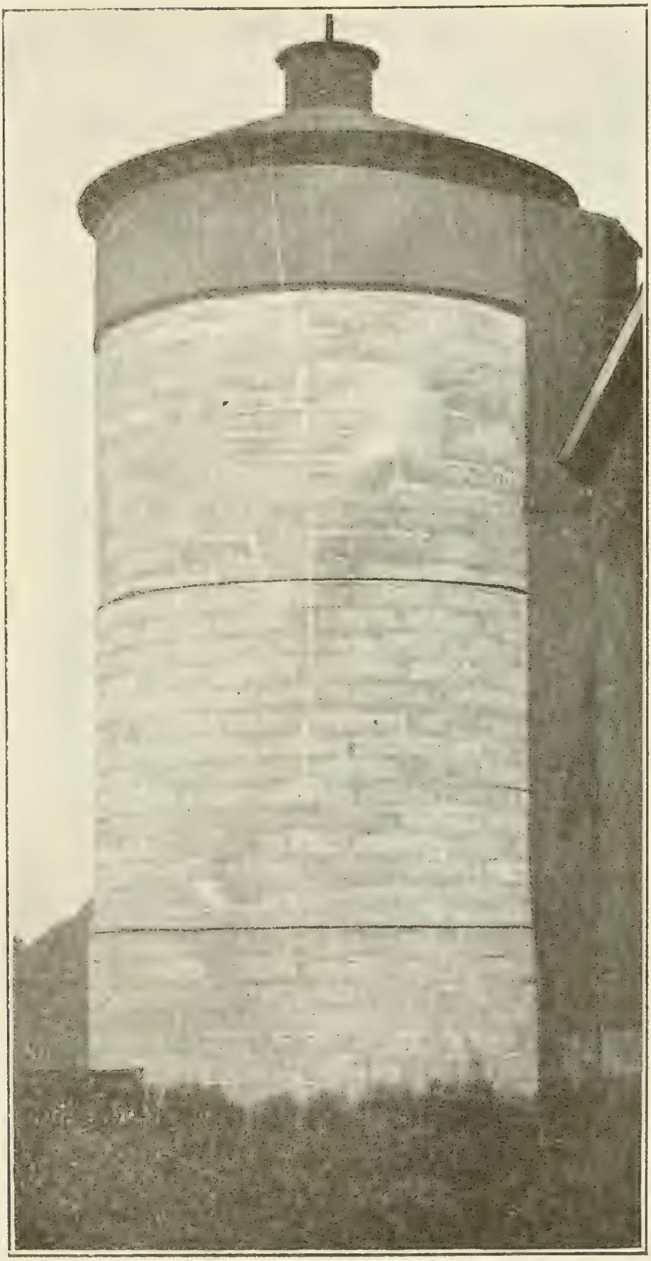


Fig. 16. The Weeks cement block silo.

inches but not all have the same thickness and structure. There are 38 tiers of blocks in the wall. The blocks of the lower 12 tiers are hollow and are 10 inches thick. Those of the next 14 tiers are hollow and are 8 inches thick. Those of the upper 12 tiers are solid and have a thickness of 6 inches. Gravelly sand and cement in the proportions of 5 to 1 were used in the construction of the blocks and it is estimated that one barrel of cement will make 16 8-inch blocks. Seven hundred blocks were required. The blocks were laid in a rich cement mortar of 2 parts sand to 1 of cement.

There are three doorways, each three tiers deep and one block (36 inches) wide. Two-inch shoulders were molded into the blocks bounding the doorways at the time of making the blocks and these shoulders carry doors made of double thickness flooring with building paper between. The lower doorway rests upon the sixth tier of blocks above the floor and each doorway is separated from next (above or below) by five tiers of blocks.

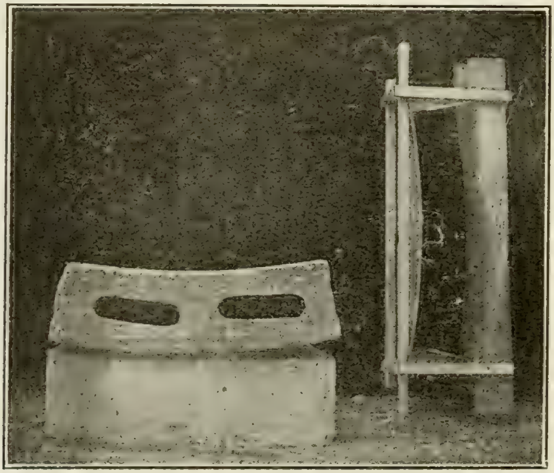


Fig. 17. Blocks used in the construction of the Weeks silo and the form used in making them.

In laying the upper tier of blocks, 12 bolts were set in alternate joints to hold the plate for a 4-foot wooden superstructure and roof.

The blocks used in the construction of the silo (see Fig. 16) were home made. The form seen in Fig. 17 is also home made. It was made of wood with front and back faces covered with sheet iron. The hollows in the blocks were made by using pieces of wood 2 inches thick, 10 inches long, 9 inches deep and slightly tapering so as to be easily removed after molding the block.

To mold a block the mold was set on its side on a cement or other floor, or plank. The wooden pieces were set on end on the floor within the mold and in such a position as to form the hollows where they should be in the block. The wet mixed material was then introduced about the wooden pieces in the mold, thoroughly tamped and struck off so that the mold was even full. The wooden pieces were then removed, the mold was carefully loosened and lifted away from the block and set again. At the end of 48 hours the blocks could be placed in the wall but it was found better to allow them to stand 10 days before placing in wall.

To reinforce the wall a No. 8 wire was laid in the mortar above every alternate tier.

As soon as the wall was constructed the inner surface received a ½ inch coat of plaster of rich cement mortar, sand and cement in the proportions of 2 to 1.

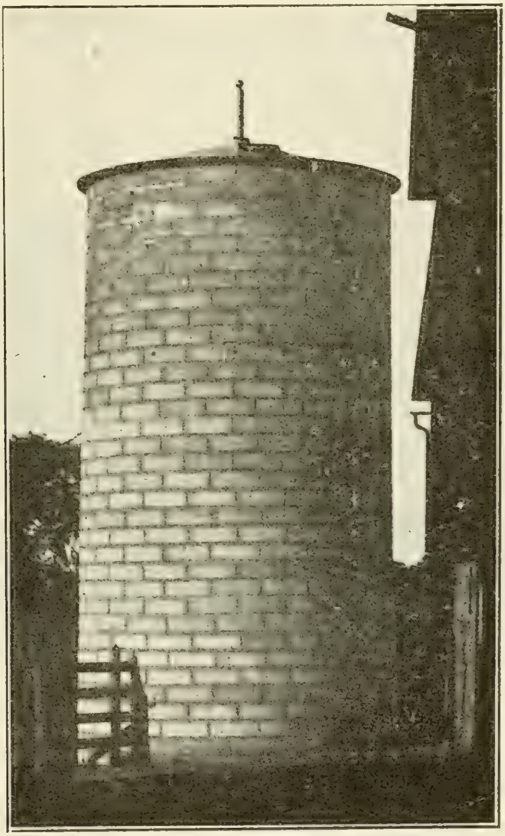


Fig. 18. Hollow cement block silo, constructed and owned by Wm. Stoll, Lansing, Mich.

A 4 inch cement floor was also put in.

Mr. Melvin Weeks, who has had much experience in concrete work, thinks that with the style of portable mold used in this work he can, with the aid of two good men, make one hundred 10 inch x 32 inch x 8 inch blocks in 10 hours.

This silo was three weeks in building and filling was begun two days after its completion. A few weeks, at least, should elapse after the completion of such a silo before it is filled. Filling the Weeks' silo so soon, resulted in a crack over each doorway. Three old hoops belonging previously to a stave silo were put about the silo, as shown in Fig. 16, and the cracks pointed with a rich cement mortar, since which the silo has worked very satisfactorily.

A diversity of views are expressed as to the effectiveness of the hollow block in preventing the freezing of the ensilage. It is asserted that in this silo the ensilage was frozen two feet back from the solid 6 inch blocks of the upper wall, but that practically no freezing occurred back of the hollow blocks below.

The quality of the ensilage in this silo is said to be very uniform throughout.

THE STOLL SILO.

Fig. 18 shows a cement block silo built upon the farm of Wm. Stoll, three miles west of Lansing. This silo, built in the summer of 1907, was planned and built by Mr. Stoll himself. It has an inside diameter of 12 feet and a height of 30 feet. In the construction of this silo a cement foundation 18 inches thick was laid extending down from the surface of the ground 4½ feet. The cement floor stands 6 inches above the base of the foundation. Upon this foundation the superstructure of 35 tiers of cement blocks is built. All but the upper 5 tiers of blocks are hollow and all have a face of 24 inches x 8½ inches. The blocks of the lower tier are 10 inches thick. Those of the second tier are 9⅞ inches thick and those of the third tier are 9 6/8 inches thick and so on up. The thickness of the blocks of any tier is ⅛ inch less than those of the tier next below.

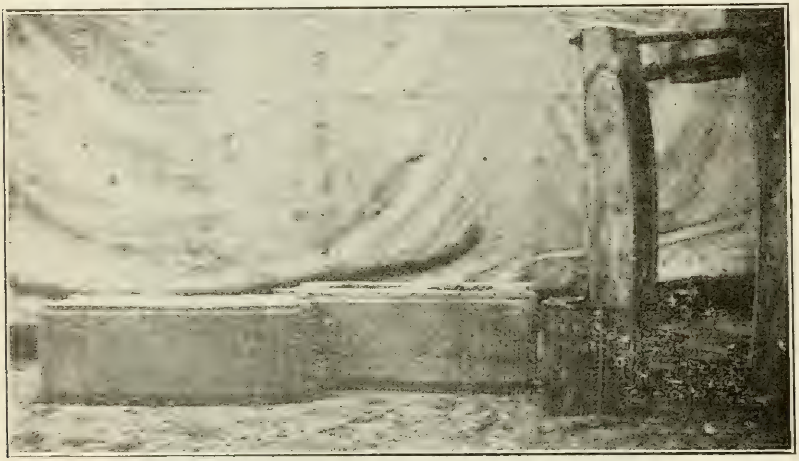


Fig. 19. Blocks used in the construction of the Stoll silo (Fig. 18) and the form used in making them.

The form used in constructing the blocks was similar to that used to make the blocks for the Weeks' silo (see Fig. 19). As soon as a sufficient number of blocks was made for any tier the outer edge of the ends of the form were trimmed down ⅛ of an inch and then the blocks for the next tier were made, and so on. The hollows in the blocks vary from 4 inches x 7 inches in the 10-inch blocks to 2 inches x 7 inches in the 6¼ blocks of the thirtieth tier.

In laying up the blocks the inner surface of the wall was kept perpendicular. When the wall was completed the inner surface received a ½ inch coat of rich cement plaster, screened sand and cement in the proportion of 3 to 1.

Fig. 20 shows a form for making cement blocks. This is a modification of the Stoll form.

There are 4 doorways to the silo, each 23 inches wide and 4 tiers of blocks high (36 inches). The lower door rests on the foundation and all the doors are separated from each other by 4 tiers of blocks. There are no door frames. The doors are very simply made of one thickness 6 inch common flooring, nailed to two cleats and just fill the opening. They rest against no jambs. Nailed upon the inner surface of each door and overlapping ends and sides by 4 inches is a piece of galvanized sheet iron. Each door is set in place from the inside and is held from slipping outward by the sheet iron. The pressure of the ensilage material against the sheet iron seals the doorway. The question naturally arises concerning the strength of this sheet iron lining used in this way. After two seasons' use there does not appear any evidence of insufficient strength in this arrangement of door.

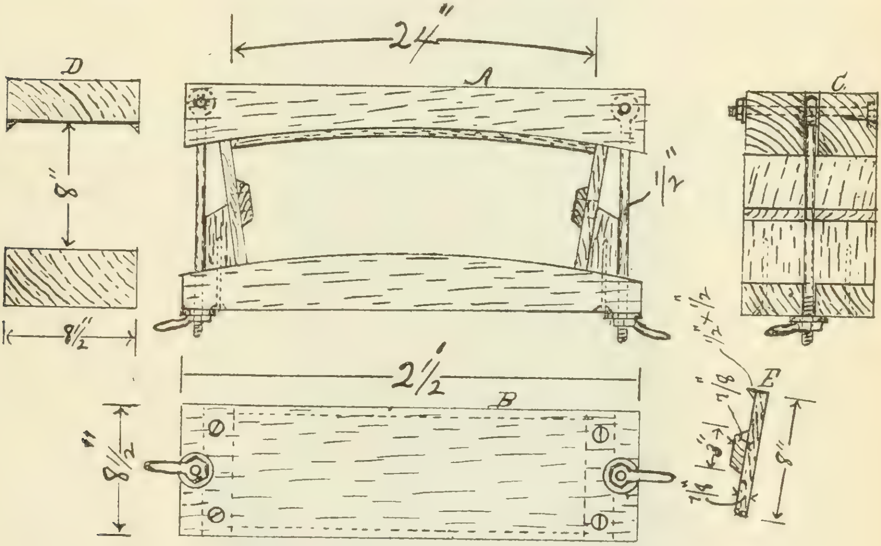


Fig. 20. Plans and elevation of form for making cement blocks.

The walls were reinforced by imbedding two strands of barbed wire in the mortar underneath the first tier of blocks below each doorway and in the mortar over the tier of blocks above each doorway.

For the roof, eight 2 x 4 rafters were used and were given a 2 feet rise to the center. The rafters were covered with sheeting, leaving a scuttle door 2 feet x 3 feet and the sheeting was covered with a 3 inch layer of cement mortar. The rafters were set upon plates bolted to the top of the wall, the bolts being set in the cement.

This silo has been filled twice. When the silage was removed it was found that for the upper few feet the ensilage was more or less spoiled about the edges but for the rest of the way it was of excellent quality right out to the edges. The writer visited the silo three different times during the first season and once the second season and examined the silage carefully.

In constructing this silo, there were used:

31½ barrels of cement,
26 cubic yards sand,
700 feet barbed fence wire.

The lumber for doors and roof cost $5.00.

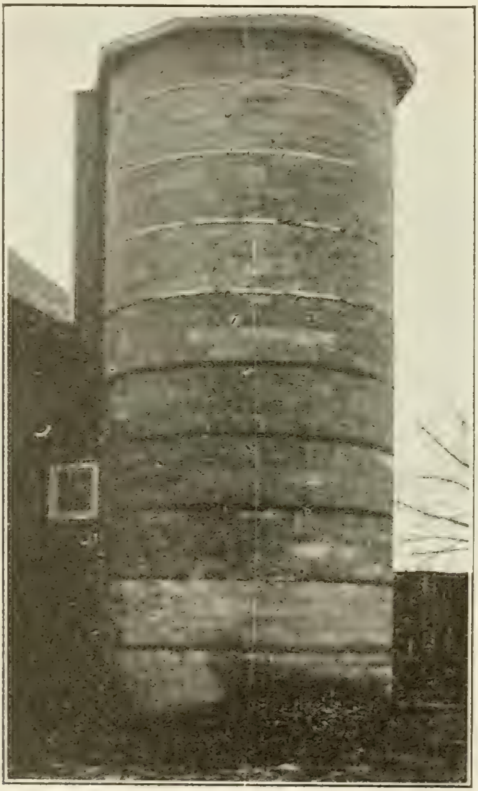


Fig. 21. Cement block silo owned by Wells Parish, Allendale, Mich.

Mr. Stoll estimates that he can make 30 blocks per day. Two men can lay up six tiers or courses of blocks per day.

Eight hours were required for two men to build the roof.

THE DE JONGE SILO.

A third type of cement block silo was discovered on the farm of Wells Parish, near Allendale, Ottawa county. Investigation shows that there are at least 25 silos of this type in Ottawa and adjacent counties. A description of Mr. Parish's silo will be of interest. See Fig. 21.

This silo has an inside diameter of 12 feet and is 28 feet high. The

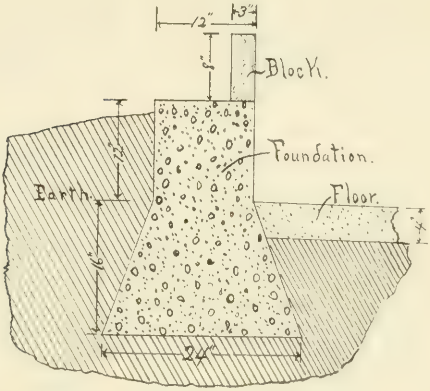


Fig. 22. Section of foundation and floor of the Wells Parish silo (Fig 21).

foundation stands 4 inches above ground and extends 24 inches below ground. The upper 12 inches of the foundation is 12 inches thick and the lower 16 inches, widens symmetrically to 24 inches at the base. See Fig. 22. The blocks used in the construction of the silo are solid, have a face 24 inches by 8 inches, and have a uniform thickness of 3 inches.

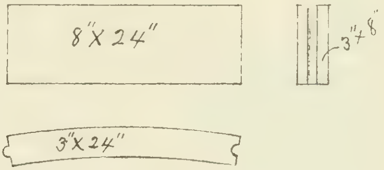


Fig. 23. Cement block used in the construction of the Wells Parish silo (Fig. 21).

See Fig. 23. The blocks are laid up in cement mortar, sand and cement in the proportions of 2 to 1, flush with the inner edge of the foundation. There is one continuous doorway, about 25 inches wide, extending from the first course of blocks to the roof. There is no door frame.

The wall is not reinforced by wires or rods embedded in the mortar between courses but is strengthened by 2 inch band-iron hoops upon the outside such as are sometimes found on stave silos. The hoops are placed four courses, or about 33 inches apart, and are drawn firmly against the walls by lugs. In the doorway behind each of these hoops is fitted a 1½ inch by 4 inch piece of wood to prevent yielding of the boundary wall of the doorway when the hoops are drawn tight. See

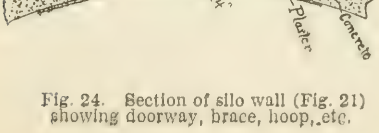


Fig. 24. Section of silo wall (Fig. 21) showing doorway, brace, hoop, etc.

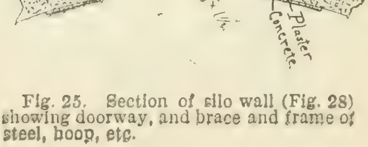


Fig. 25. Section of silo wall (Fig. 28) showing doorway, and brace and frame of steel, hoop, etc.

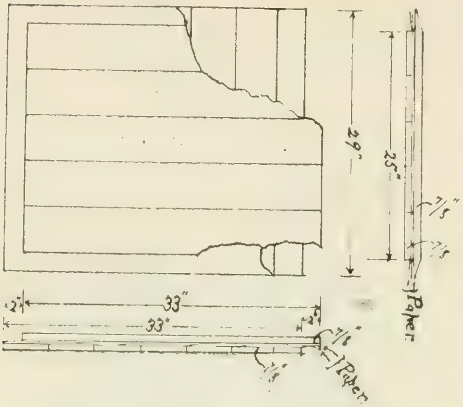


Fig. 26. Door used in silos shown in Figs. 21 and 28.

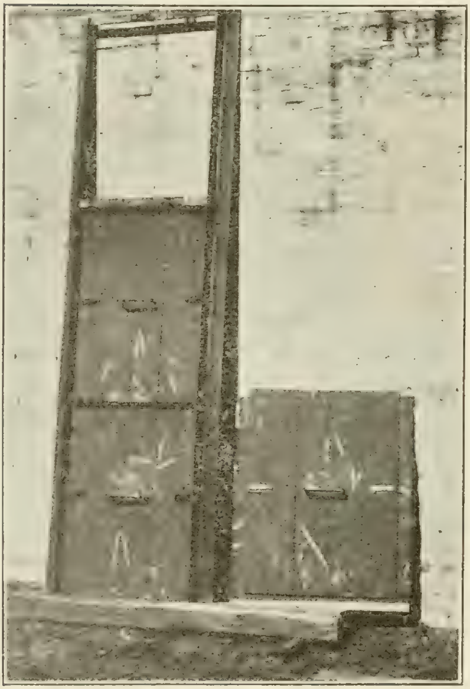


Fig. 27. Steel door frame with doors used in the silo owned by William Schipper. (Fig. 28).

Fig. 24. These pieces act also as supports to which are nailed pieces of 2 x 4 for frames for chute, and for ladder for reaching the upper portions of the doorway.

The doors, made in sections, are formed of two thicknesses of flooring with two thicknesses of tar paper between. The inner thickness of flooring, which sets horizontal, laps 2 inches when in place, as does the paper, on either side of the doorway and rests against the inner surface of the wall. The sections are made to lap upon each other also. See Figs. 26 and 27. These doors are held in place by the pressure of the silage. The ends of the inner layer of boards are beveled back to the wall.

When the silo was first built the inner surface of the wall was not plastered but was treated with an application of a preparation (probably water-glass) which was recommended as having the property of closing the pores of the concrete and thus rendering it air tight. It did not accomplish this result. That year as much as 6 or 8 inches of all the ensilage next to the wall spoiled completely. Before filling the silo again the inner surface of the wall received a ½ inch coat of rich cement plaster. When the plaster had set it was given a coat of rich cement wash. Since that time there has been no poor silage, so Mr. Parish reports. The writer examined the silage in this silo, in the month of April, 1908, and found that next to the wall thoroughly bright and sweet.

Proportions of materials used:

For the foundation, 1 part cement to 7 of gravelly sand.

For the blocks, 1 part cement to 5 of gravelly sand.

Floor, made wet, 1 part cement to 5 of gravelly sand.

Mortar for laying *wall* and *plastering*, 1 of cement to 2 of screened sand.

Wash, cement and water.

Roof:

The roof consists essentially of eight rafters set at low pitch, covered with sheeting (flooring in this case) and the sheeting in turn covered with rubberoid. A section of the roof is removable and through this doorway the ensiling material is introduced.

This silo was built by contract for $176.00 complete. It has been in use five years.

A cast iron form was used in making the blocks. Such a form can now be purchased on the market and will cost something like $15.00.

Other silos of this type were visited. Most of them were 12 feet in diameter but differed in height and some possessed at least one new feature. A silo owned by William Schipper will illustrate. This silo (see Fig. 28) is 12 feet inside diameter and is 34 feet high. Four feet of this height is below ground. The 24½ inch continuous doorway has a frame of 3 inch by 3 inch by 3-16 angle iron. (See Figs. 25 and 26.) Braces of ¼ by 1½ inch iron are bolted to the opposite angles and at intervals of 33 inches fall under the hoops, as did the wood pieces described in the Parish silo. This frame is set to receive in the angles of the frame the inner corners of the blocks bounding the doorway and gives to the doorway both strength and durability. The plaster applied on the completion of the wall is reduced in thickness, next the doorway, to that of the angle iron.

Mr. Schipper's silo is covered by a shingle roof. Fig. 28 gives a clear idea of the roof.

The blocks for Mr. Schipper's silo were made by himself but he hired the labor to build them into the wall. He estimates that the silo complete cost him about $150.00.

The materials used in building foundation and walls were:

15 barrels of cement,
14 loads of gravelly sand,
The steel door frame, cost $12.00.
11 hoops, cost $18.00.
11 doors, cost $11.00.

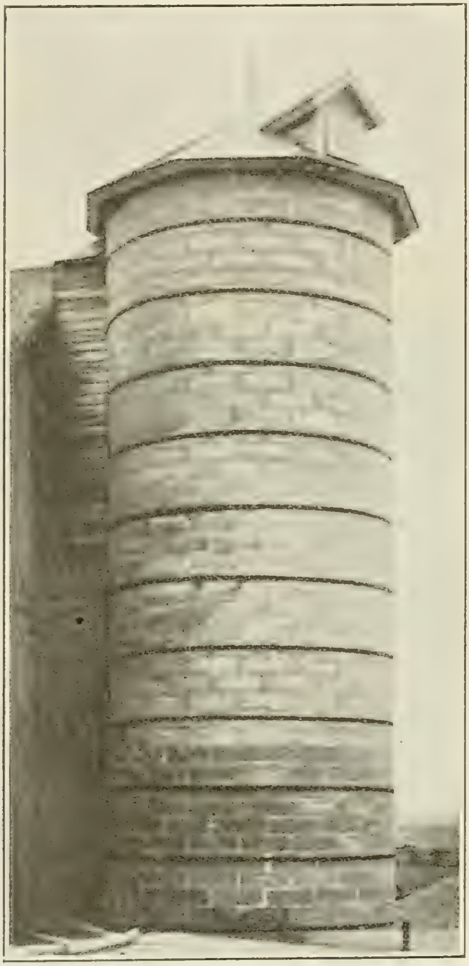


Fig. 28. Silo owned by William Schipper.

Two objections are heard against this type of silo:

1st. The walls are so thin (3½ inches complete) that the silage must freeze badly. To this the owners with whom we have talked say, "It is not true. The freezing is not more severe than in a stave silo."

2nd. The walls are not thick enough to be sufficiently strong to endure the strain to which they are subjected. The writer has been troubled with doubts of the same nature. He has examined two of these silos that have been in use for five years and was unable to discover check or flaw indicating that this judgment is correct and, furthermore, it appears that not one of the 25 or more silos of this construction has shown evidence of such weakness.

A FEW COMPARISONS.

The relative merits of the solid wall silo and the cement block silo have not been discussed and little need be said upon this point. Both types of silos are in successful operation. Unless proper care is exercised in construction to make the walls air tight, neither can be expected to produce good ensilage. There is probably no foundation for the opinion that the ensilage produced in a cement silo is more acid than that produced in a wooden one, because the "cement silo is colder than the wooden one." A series of temperature determinations show that the heating in the cement silo is as great as it is in the wooden silo. If it be true that the acidity is greater in the cement silo, some other explanation must be sought.

At the present time the cement block silo is more popular than the solid wall cement silo. Two reasons may be assigned for this fact:

1st. The expense and labor entailed in building forms for a solid cement wall are considerably greater than in building a form for making cement blocks. When forms are built for a single solid wall cement silo this difference in expense is magnified. This observation does not hold where the professional silo builder is employed.

2nd. The work of constructing the cement block silo seems to be more attractive than that of constructing the solid wall silo.

We shall find generally that in the home made silo the block wall is better and more symmetrically constructed than is the solid wall.

MATERIALS NEEDED FOR THREE DIFFERENT KINDS OF SILOS.

That the reader may have some basis for comparison in estimating the cost of different kinds of silos the following approximate figures are given for a silo 12 feet inside diameter and 30 feet high:

STAVE SILO.

The inside circumference of such a silo is 37 feet 8½ inches. If 2 feet is left for doorway and the adjacent staves are used for door frame, then 35 feet 8½ inches divided by the width of stave used will give the number of staves required for one course of staves. If the staves for the two courses be 14 feet and 16 feet long respectively and 5¾ inches wide, there will be required 75 staves 14 feet long and 75, 16 feet long.

There will be required also 14 hoops of ½ inch or ⅝ inch round iron with lugs.

ALL WOOD SILO.

Frame:

For sills (one thickness of 2 x 4) and for plates (two thicknesses of 2 x 4), 9 pieces 2 x 4, 14 feet long.

For studs:

38 pieces 2 x 4, 14 feet long.
38 pieces 2 x 4, 16 feet long.

Sheeting:

The sheeting for the inside must be of two layers with tar paper between. Acid proof, water proof paper is better than tar paper. Three pieces 12 feet long or two pieces 14 feet long and one piece 8 feet (½ of 16 feet) long will reach around from door frame to door frame. There are 36x30=1,080 square feet of surface to be sheeted with two layers of sheeting, requiring actually 2,160 square feet of sheeting, but since sheeting like other lumber, falls short of full width, 1-12 must be added if 3 inch sheeting is used. The amount to be purchased is 2,340 feet. Be sure to buy in lengths that will work into 36 feet courses without excessive cutting.

Paper:

There will be 1,080 square feet to cover with tar paper, and including the lap will require not far from 1,200 square feet of paper.

Siding:

The courses of siding will be 38 feet long. Two 12 feet lengths and one 14 feet length will cover this. There will be 38x30=1,140 square feet to cover with siding, and in purchasing, allowance must be made for lap.

CEMENT SOLID WALL AND BLOCK SILOS.

The amount of material required will be nearly the same for the two silos.

To make the blocks for the Stoll silo there were required:

27 barrels of cement,
23 loads of sand (23 cubic yards).

To make the blocks for the Schipper silo (if it had been built 30 blocks high) there would have been required:

10½ barrels of cement,
10 loads of sand.

For the foundations of any of these silos there would be required:

3 barrels of cement,
3 cubic yards of sand and gravel.

See Fig. 29, which gives a general idea of how such a foundation should be built. The doors and roofs should not differ materially for the same style.

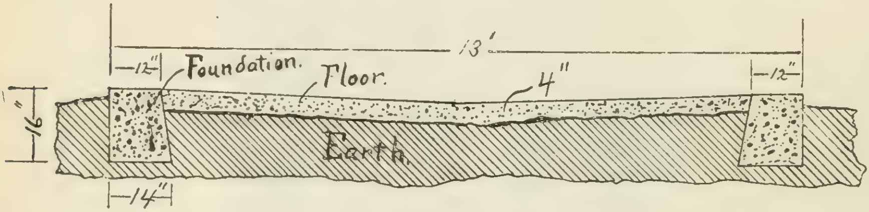


Fig. 29. Section of silo foundation with floor at surface of ground.

CAPACITY OF SILOS.

The capacity of a silo depends upon:

1st. Its diameter.

2nd. The depth of the silage in it.

A silo with a diameter of 12 feet and with the silage standing 20 feet deep two days after filling, contains approximately 37.66 tons. With the silage standing 25 feet deep, it contains approximately 51.58 tons and with the silage standing 28 feet deep two days after filling, it contains 60.8 tons.

In the table below is given other data concerning the contents of such a silo, 12 feet in diameter:

Depth of silage two days after filling.	Tons contained.	No. of days 20 cows could be fed 30 lbs. each per day.	Average rate at which the silage would be lowered per day in inches.
20	37.66	125	1.9
25	51.58	172	1.7
28	60.8	202	1.6

If the animals were fed 40 pounds of ensilage per day, the feeding could continue but three-quarters as long, and the lowering of the ensilage would be one-third faster.

At the same rate of feeding as indicated in the table, a silo 14 feet in diameter supports 27 cows for the same periods. A silo 15 feet in diameter would support 31 cows and a silo 16 feet in diameter would support 35 cows for the same periods.

The capacity of a silo increases more rapidly than the depth.

AN IMPORTANT PRECAUTION IN REGARD TO THE FILLING OF SILOS.

The quality of the ensilage will depend in no small degree upon the care and thoroughness with which the materials are introduced into the silo at the time of filling. There are many good cutters and the farmer's selection of a machine must be governed by his taste, needs and funds. The proper filling of the silo, however, is imperative. The packing must be done in such a way as to exclude the air as completely as possible. The amount of work required to accomplish thorough packing will, no doubt, depend upon the maturity of the material to be ensiled. Cases have been reported where little or no (?) packing by tramping was required as the material was distributed by manipulating the hood of the blower. These are rare cases. The instances of loss by insufficient and improper packing are numerous. One case was recently observed where for a considerable depth right in the center of the silo numerous small spots of spoiled ensilage occurred, apparently because of insufficient packing.

Another case was observed where the workmen failed to tramp properly one area on one side where the material was delivered from the machine, because they would not submit to the bombardment of pieces of cobs, etc., from the blower and where also, because of the delivery in this particular place, the material could not be properly distributed.

Careful distribution of material and persistent tramping are necessary to proper success.

Unless the material is distributed by an adjustable hood, it should be delivered at the center of the silo and distributed from that point with a fork.

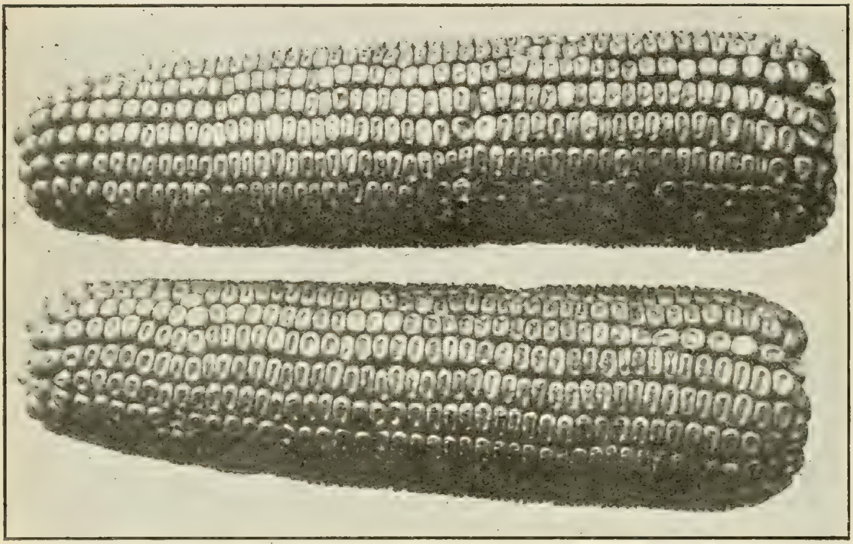


Fig. 1.—Two Michigan grown ears of Ried's Yellow Dent.

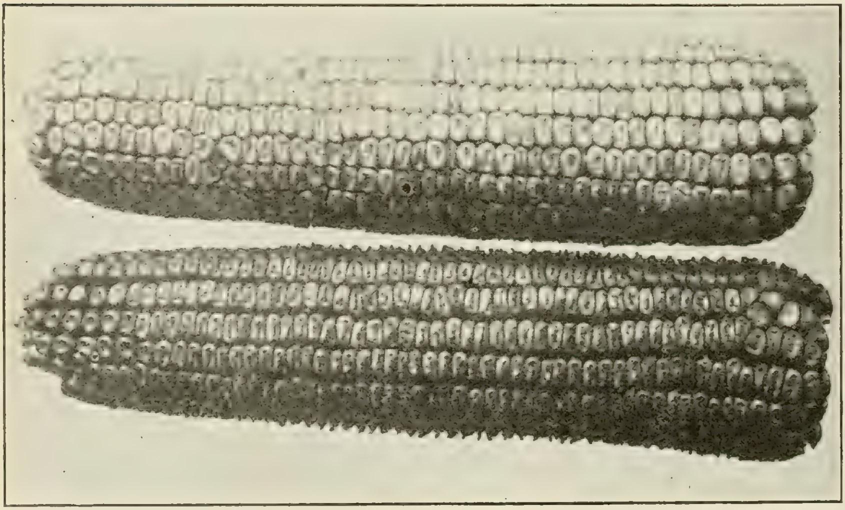


Fig. 2.—Two Michigan grown ears. The upper one is of the Hathaway's Yellow Dent.

CORN IMPROVEMENT.

BY J. A. JEFFERY.

Special Bulletin No. 47.

In 1906 Michigan grew 1,475,000 acres of corn, producing 54,575,000 bushels worth $24,013,000.

The average yield for that year was 37 bushels per acre. The average yield for the ten years, from 1897 to 1906, was 32 bushels per acre,

for Kansas was 22.0,
for Nebraska was 27.7,
for Iowa was 32.5,
for Illinois was 34.0,
for the seven corn belt states was 30.5,
for the United States was 25.4.

It is seen that the yields of corn in Michigan compare very favorably with those of other states. Michigan cuts practically all of her corn for the fodder or ensilage, while in most of the belt states comparatively little, and in some almost none, is cut for these purposes. These facts add importance to the corn crop of this state.

ACTUAL YIELDS VS. POSSIBLE YIELDS.

The average yield of corn in Michigan for the ten years indicated is 32 bushels or 64 baskets. Compared with the average yields of the states named above, this does not appear so bad. But let us observe from another view point. The reader will have little difficulty in procuring from the crib an ear of corn that weighs approximately nine ounces, and one that weighs approximately eleven ounces. The field of corn that averages two nine-ounce ears of corn to the hill with the hills three feet eight inches apart, will yield 104 baskets to the acre, while the field that produces two eleven-ounce ears to the hill with the hills three feet eight inches apart will yield 127 baskets per acre. Neither of these propositions seems extravagant; for it is not an uncommon thing to find many hills in a field bearing four ears to the hill and the ears weighing from nine to eleven ounces each. But observe that the two eleven-ounce ears to the hill gives a yield of 127 baskets to the acre which is practically twice the average yield of corn in Michigan for the past ten years. Why, then, should the average yields fall so far below what seems so easily possible? There must be causes and it should be possible to remove them.

CORN CULTURE.

In the study of corn culture, the ultimate object is to procure the largest possible yield of grain and fodder. To do this we must have:

1. Strong vigorous plants,
2. The right number of these in each hill, and
3. Each plant, or stalk, producing at least one good ear.

To secure these there must be

1. Good seed corn,
2. Good soil, and
3. Good practice.

SEED CORN.

The most vigorous plants can be produced only from a good quality of seed corn. Such corn can be best selected from the stalks before harvesting. Seek for ears

1. Of good size and proper proportions,
2. Properly situated on the stalk, not too high and not too low,
3. With the ear pendent.

The parent stalk should be of good size and it is desirable that it have an abundance of leaves. In Michigan we grow corn for fodder as well as for grain.

The ears may be removed from the stalks as rapidly as they are selected. Not a few practical farmers, however, and some investigators urge that the ears should remain upon the stalks until husking time. If this practice be followed, then, as rapidly as the ears are selected, as described above, they should be marked by tying a bright string upon them or in some other way, so that the huskers may recognize them at husking time and set the ears apart. Many ears selected in this way may be found to be unsatisfactory in size, shape, etc., for seed purposes when husked.

PRECAUTIONS.

In selecting seed ears remember that in drying they will probably shrink at least ten per cent, both in length and circumference. A ten-inch ear will shrink in drying to nine inches.

It hardly seems wise to select the earliest maturing ears if they mature unduly early. It would seem better to select ears that mature just sufficiently early to be out of the way of the average early frost. In other words, the corn plants should use the longest safe growing season.

At least a sufficient amount of seed corn should be carefully selected as above described to plant a few acres from which to select the next year's seed. The rest of the seed may be selected, and often is, from corn husked from the shock, but that so selected, should be from the corn grown from the carefully selected seed of the previous year. All seed corn taken from the husked corn should be selected before freezing can occur. Authorities are agreed that the freezing of corn before it is thoroughly dry lessens its vitality.

Fig. 3 shows a section of germinator with a row of plants from carefully saved seed from the crop of 1907. Fig. 4 shows a section of germinator with a row of plants from the same number of the best ears to be found in a crib from the crop of 1907 and coming from the same field as those that were carefully saved.

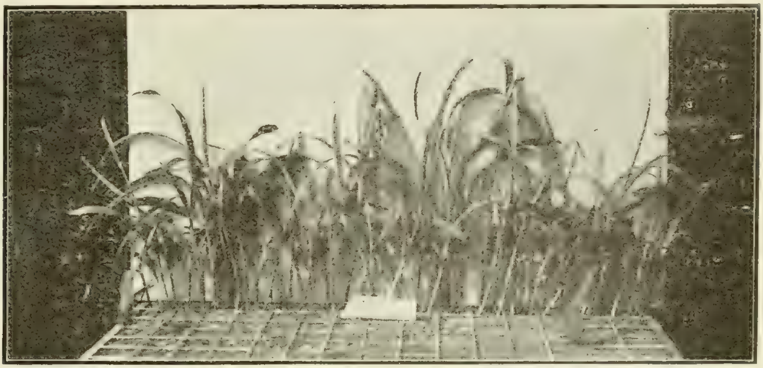


Fig. 3.—The plants from 15 ears carefully saved seed corn, in germinator test.

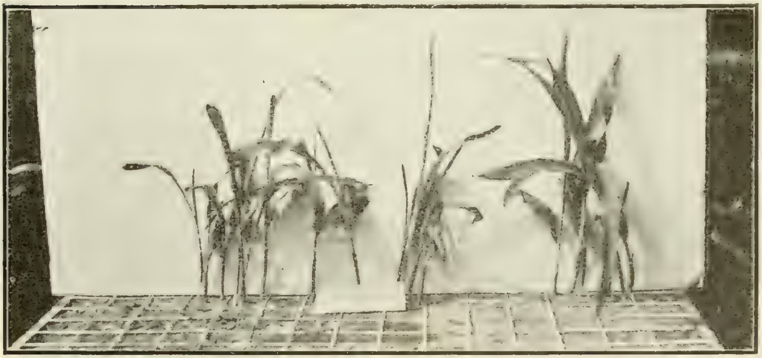


Fig. 4.—The plants from 15 best ears selected from crib in spring 1908, in germinator test.

DRYING.

All corn selected for seed should be at once stored in a warm, dry, airy place to dry. A furnace room is good if it complies with the three named conditions. It may do to leave the corn in crates, but there is more or less danger in the practice, and especially if the corn is over-moist. The crate is *not* safe.

Fig. 5 shows an excellent cheap rack, with corn in place. The racks are twelve feet long and ten feet high. The posts, which are of 2x4 hemlock, stand four feet apart. The horizontal strips are cut from sound hemlock or pine boards 1x⅞, and are set in pairs as shown. Each pair carries a tier of corn. The distance between any pair and the one above is four inches. Six-penny nails should be used in nailing on the strips. The seed corn should be placed in rack as shown.

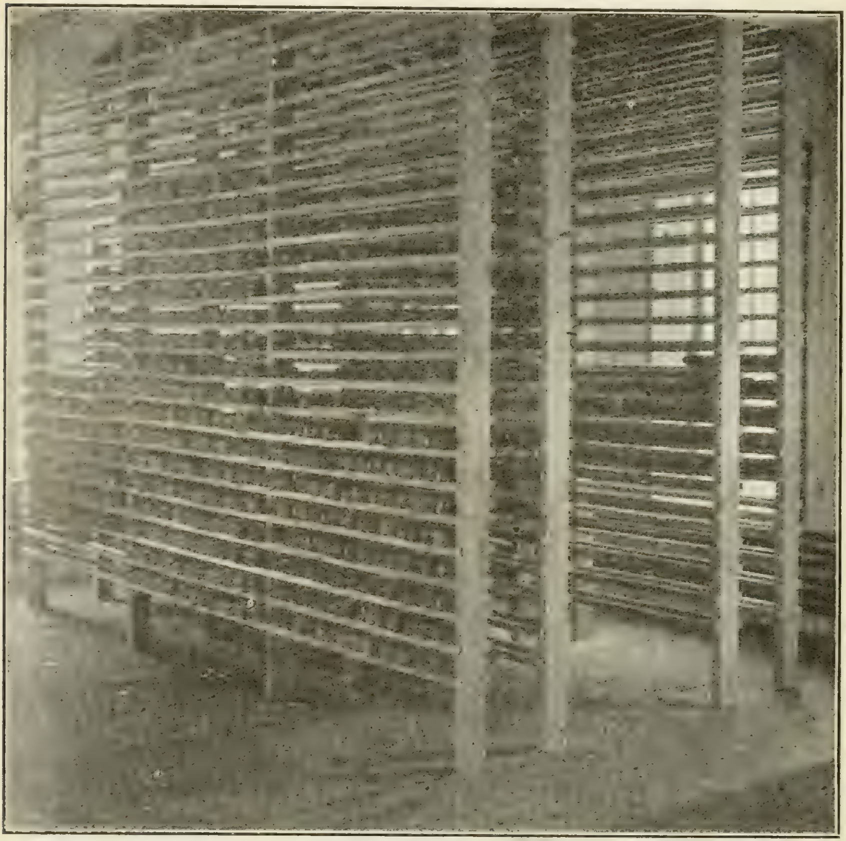


Fig. 5.—A practical rack for drying seed corn.

Fig. 6 shows a scheme brought to our notice by Mr. Orin J Bemis, of Ypsilanti. It may be made of a four-foot piece of 2x2 inch material or of two-inch to three-inch sapling. Finishing nails are driven into the piece two and one-half to three inches apart, according to the size of the ears to be dried upon it. A hole bored through the piece near the top allows the fastening to it of a wire or string by which it may be suspended from a beam, as shown in Fig. 7.

Another interesting scheme for drying seed corn is shown in Fig. 8. It consists of a cedar post nailed to a frame of 2x4's, each piece four

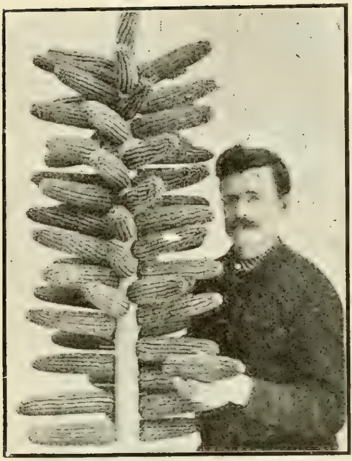


Fig. 6.–The Bemis rack with ears in place.

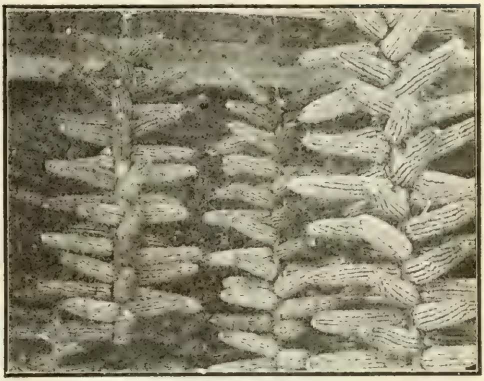


Fig. 7.—Bemis racks filled with ears and suspended from joists.

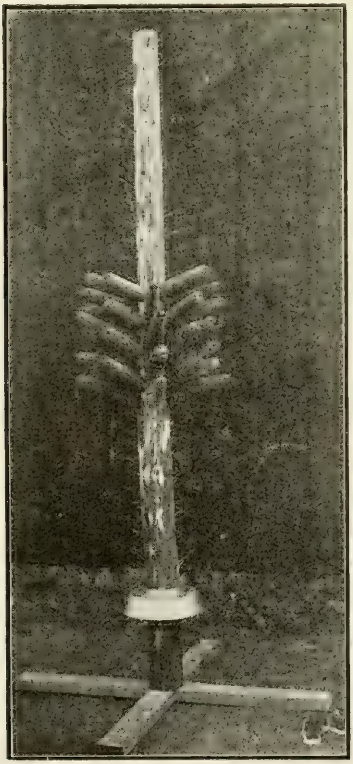


Fig. 8.—Corn rack made of a fence post.

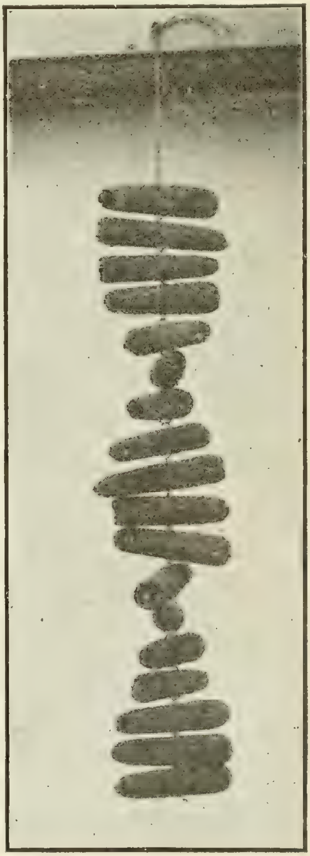


Fig. 9.—Seed corn suspended by binder twine

feet long and the two set into each other at right angles as shown. A piece of sheet iron or an old pan is fitted about eighteen inches above the lower end, as shown, to prevent mice and rats from getting at the corn.

Above this iron or pan twenty-penny wire finishing nails are driven at intervals of two and one-half to three inches, according to the size of the ears to be dried. This particular post is five inches at the bottom and carries 165 nails. A larger post would carry more. A cross-piece is sometimes nailed to the post about four feet above the base, to be used in moving it.

Fig. 9 shows a very simple and satisfactory scheme for hanging seed corn to dry, recommended by Professor Holden, of Iowa. It consists of a six-foot piece of binder twine. An ear of corn is placed at the middle of the piece of twine and a single tie or knot made, as shown in Fig. 10. A second ear is tied over the first with a single knot, and so on till one and one-half to two dozen ears are tied in the string. Then the upper ends of the twine are fastened to a nail in a beam, or to a wire stretched between beams or posts.

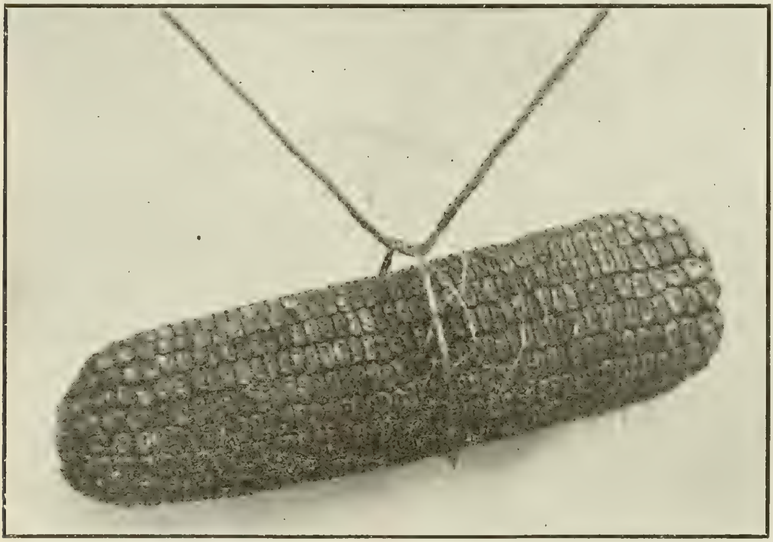


FIG. 10.—Shows the manner of tying the ears together with binder twine.

But wherever placed, the corn should be thoroughly and quickly dried. This removes the possibility of molding and consequent lessening of vitality. A temperature of a little above ordinary room temperature is suggested till the corn is well dried; then a temperature anywhere above the freezing point is considered satisfactory. It is thought by many that well-dried seed corn will not have its vitality lessened by freezing. Others never allow seed corn, however well dried, to freeze. There can be no doubt that the latter practice is safe.

Seed corn taken from the crib in the spring cannot have the vitality of properly cured corn, and this in face of the fact that the crib corn may show a hundred per cent of germination. The relatively damp condition, and the occasional or continued freezing of winter make perfect vitality and vigor impossible. In an ordinary test, rack dried corn germinated ninety-nine per cent; crib corn tested seventy-seven per cent. The winter had been a very mild one, too. See Figs. 3 and 4.

TESTING OF SEED CORN.

It is a good practice to test the germinating quality of every ear of the seed one is planning to sow. The undertaking is not a difficult one. Fig. 11 shows a germinator used by the farm department of the

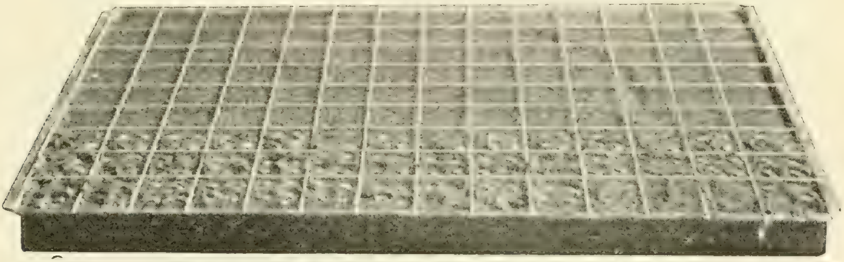


FIG. 11.—Galvanized iron germinator. Small notches are cut in the rim at intervals of 1¼ inches to carry the string or wire which divides the germinating surface into 1¼ inch squares. This figure shows four rows of kernels in place.

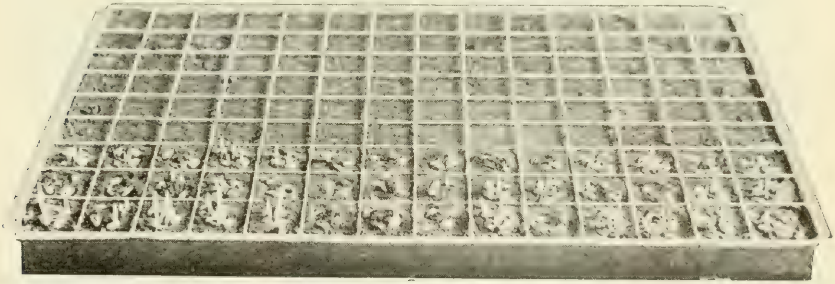


FIG. 12.—Same as figure 11, after four days.

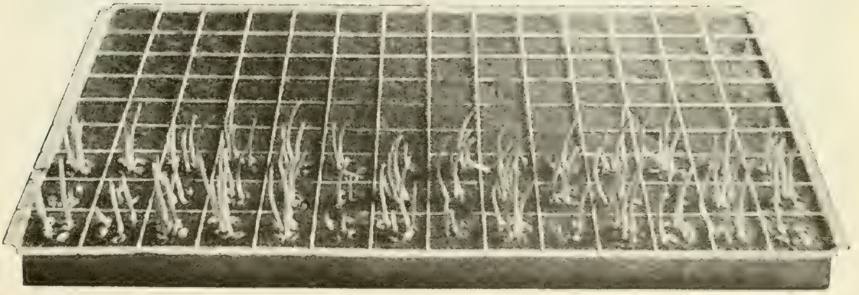


FIG. 13.—Same as figure 11, after seven days.

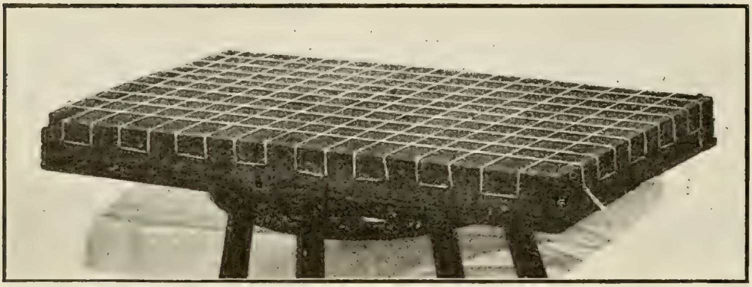


FIG. 14.—Germinator made of a soap box, ready to receive the kernels from ears.

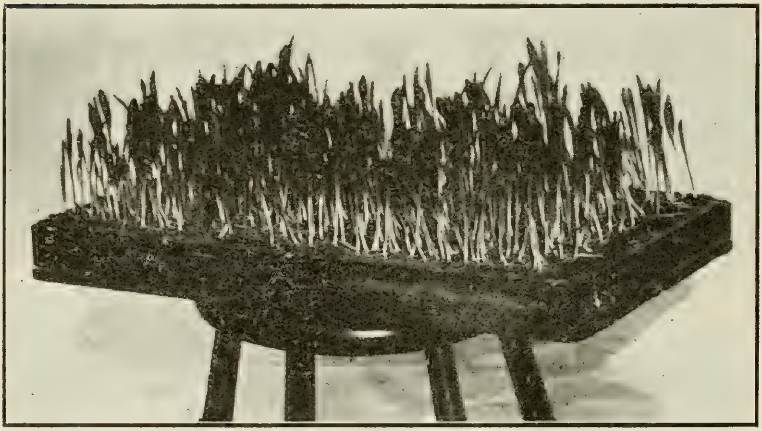


FIG. 15.—Germinator made of soap box with plants sufficiently developed to indicate the quality of the ears from which the kernels in the test were taken.

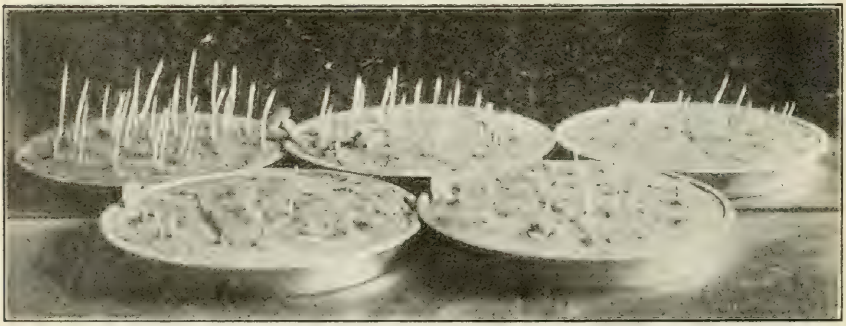


FIG. 16.—Twenty-five kernels of corn from each of five carefully saved ears of seed corn were planted in these five pans respectively. A careful examination reveals the fact that there is a great difference not only in the germinating qualities, but in the vigor of the resulting plants. We have, here, an excellent illustration of the importance of testing seed corn by individual ears.

college. It is 11¼x17½ inches inside measure, and is one inch deep. It is made of galvanized iron. Notches are cut one and one-quarter inches apart in the rim or flange. The germinator is filled with sand or sandy soil, and stricken off with a straight edge, and then lightly tapped to settle the sand. A string is then stretched as shown, marking one and one-quarter inch squares. This gives 126 squares. Five or six such trays will hold the kernels from five to eight bushels of corn. One tray will hold the seed from seventy-eight pounds of ten-ounce ears.

Figs. 14 and 15 illustrate a germinator made by cutting down a soap box gotten at a grocery store. Tacks or very small nails are driven into the sides (not the edges) of sides and ends, one and one-quarter inches apart, to carry the string.

Place the ears of seed corn in rows of fourteen ears each, either on racks or elsewhere, i. e., as many ears as there are squares in one of the long rows in the tray, numbering the rows of ears to correspond with the rows of squares in the tray. Take each ear separately, remove four kernels from as many different points on the ear, and set them, small end down, and germ side in, in the square corresponding to the ear. Press each kernel down till its' top is even with, or better, just below the surface of the sand, as shown in Fig. 11. Each tray provides for nine rows of ears.

Next, wet the sand in the germinator thoroughly, and leave in a warm place, at room temperature, or slightly higher. See to it that the sand is kept well moistened, but not saturated.

Fig. 11 shows the corn in place, Fig. 12 shows the corn germinated, and Fig. 13 shows the corn after some growth is made. It is only after the corn has had an opportunity to grow several days that one can pass intelligently upon the vigor of the germinating kernel. It is not sufficient that a kernel of corn germinate. Discard all ears whose kernels do not *all* germinate *rigorously*, if you would have a perfect stand of vigorous plants. See Fig. 16.

TIP AND BUTT KERNELS.

Tip kernels should be removed far enough back to insure freedom from molds which are likely to be found where the ends of the husks have allowed moisture to enter before husking. Aside from this, tip and butt kernels are objectionable only so far as their presence interferes with an even stand, where planting is done with a machine. Grading, or screening the corn, insures an even stand where a planter is used.

Figs. 17 and 18 show the germination and growth of tips, middle and butt kernels from the same ear, and this is in accord with a considerable number of tests made by one of our college students some years since. Not all breeds of corn give the same results. Occasionally the results are reversed.

THE SOIL.

Well-manured, well-prepared clover sod is the ideal place for corn. Timothy sod is objectionable in Michigan, for the reason, according to Professor Pettit of the Experiment Station, that the timothy bulbs are the breeding places from which come the wire worm, the cut worm, and the corn bill-bug, all serious enemies of corn. The ideal type of soil for corn is the loam, or sandy loam, with a rather open, not sandy, sub-soil.

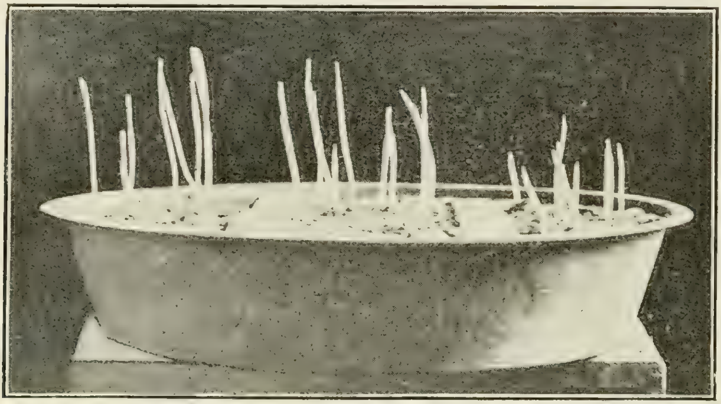


Fig. 17.—The young plants at the left are from tip kernels, those in the middle are from middle kernels, and those on the right are from butt kernels, all from the same ear, and planted at the same time.

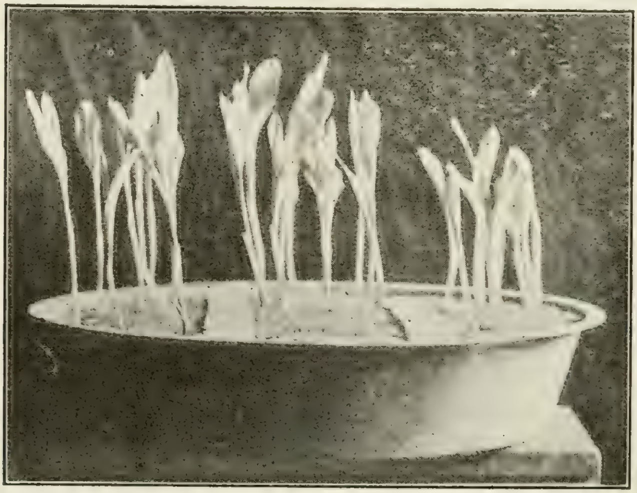


Fig. 18.—Same as figure 16, after four days.

THE MANURE.

There is a difference of opinion as to when the manure should be applied to the clover sod. If the soil is reasonably good, the manure might profitably be applied to the pasture, thus giving the pasture the benefit of the manure. The corn will profit largely from it. The practice of top-dressing—of applying manure after plowing—is coming much into favor.

THE PLOWING AND OTHER PREPARATION.

Plow reasonably deep, in good time, at least two weeks before planting, and more if possible. Roll to bring the newly turned soil into contact with the lower soil. Disc or spring tooth well. Follow with a peg tooth harrow. Work often enough thereafter till planting time, to keep the soil fairly mellow to a depth of three inches. Early plowing and subsequent working promote proper conditions of moisture, ventilation and temperature, all of which are so necessary to an abundant supply of available plant food for the young crop of corn. Young plants as well as young animals profit by a good supply of food, and suffer as well when the supply is insufficient.

PLANTING.

Plant as early as soil conditions will permit. Plant only so deep as may be necessary to insure sufficient moisture to the germinating kernel. The kernel and the succeeding plant both need the warmth of the sun. The depth will be greater in sand than in clay.

Three kernels to the hill is considered good planting. If the seed is of high quality, and the ground well prepared, this should insure a good stand.

The question of hills as against drills is one that should be settled by each individual for himself. The use to which the crop is to be put must be a factor in deciding the question. It is generally thought that a given number of plants, distributed one in a place, will give a larger yield than if planted in hills of three or four plants in a place, but occupying the same total area. This is denied by some good authorities. Prove it for yourself.

After planting, harrow at least once before the corn comes up, to destroy starting weeds, and to loosen the soil. Our best corn growers harrow once or twice more before the cultivator is started.

After the corn is well up count the number of plants per hill in a number of different rows in different parts of the field. If you find hills with less than two stalks or any considerable number of hills with only two stalks, there is something wrong. Such failures may be due to

1. Poor seed,
2. Failure to cover seed because the ground is rough or the soil has been insufficiently mellowed,
3. Poor planter,
4. Poor help,
5. Animals—crows, gophers, moles, etc.

any of which, save possibly the last, indicate poor management, and should be remedied another year.

CULTIVATING.

Cultivate often enough to keep the soil free from weeds and thoroughly stirred to a depth of two inches up to the time of tasseling.

Most of our best corn growers continue to cultivate even after the corn has tasseled.

BARREN STALKS.

When the ears have well set, count and record the number of stalks bearing no ears. If there are many of the latter, some way should be sought to lessen the number in the future. The presence of such stalks may be due to at least two causes, (1) inherited barrenness, (2) to improper nutrition.

CORN IMPROVEMENT.

In the improvement of corn the following things are sought, and in the order named:

1. Increased yields.
2. Improved qualities.
3. Fixation of character—prepotency—the power to transmit to succeeding generations certain well-defined fixed characters and these within reasonably narrow limits.

INCREASED YIELDS.

In improving for yields merely, it is sought to increase the power of the plant to use larger amounts of food and produce more grain or fodder, or both. The plant must have more energy. To accomplish this end two lines of procedure are open to us:

1. Selection:
   (a) general.
   (b) controlled.

2. Cross fertilizing:
   (a) general.
   (b) controlled.

The real work of improvement in both cases will be done in plots, and as described here, may be taken up by any farmer interested in corn improvement.

SELECTION.

This work begins in the field of growing, ripening corn. The field is explored for the most perfect ears in size, form and depth of kernel found on the most perfect stalks as regards foliage, size, energy and time of maturing ear. Generally, not many ears will be found coming up to the ideal of the experimenter. These ears should be carefully saved for planting.

(1a) The grain from these ears may be mixed and planted in an area by itself away from the rest of the corn on the farm, or the area may constitute a part of the regular corn field; but in the latter case, it should constitute the southwest corner of the field because the winds in Michigan are chiefly from the southwest, and, while from that direction, will not bring pollen from the poorer parts of the field to cross upon the supposed better corn of the breeding plot. If, however, some neighbor is growing another breed of corn near by this southwest corner, it will not be desirable to use this corner for the breeding plot, because pollen from the neighbor's corn is likely to be blown into it.

At ripening time the few best ears of this plot are selected, as before described, for next year's breeding plot, while other good ears should be saved for a general seed plot in the field for next year. Or, if this breeding plot be of considerable size, it might be possible to select seed enough for planting the whole field next year. This plan has been practiced in Michigan with good success.

(1b) Instead of mixing the corn from the several ears, the corn from each ear might be sown in a row or block by itself in the breeding plot. This gives a chance to study the progeny of each ear by itself and to select the best of the progeny of the best ears. There arises the difficulty in this plan, that the best ear in any row planted from the best ear, may be the product of the crossing of the pollen from a row planted from a very poor ear, as shown by its "performance," upon this row planted from the best ear.

CROSS-FERTILIZING.

(2a) Two ears of apparently good quality may be selected for cross-breeding, and with the idea of breeding ear No. 2 on ear No. 1. A block of land, say five rods by three rods, may be laid off and marked. In rows 1, 3, 5, 7, 9, 11 and 13 the grain from ear No. 1 is planted, while in the even-numbered rows—2, 4, 6, 8, 10, 12 and 14—the grain from ear No. 2 is planted. At tasseling time the tassels are removed from the odd numbered rows as rapidly as they begin to appear. The ears forming on the stalks of the odd rows must be pollinated by pollen from the even-numbered rows. The matured ears on the odd rows are seen to be the result of cross-fertilization—are the progeny of the crossing of ear No. 2 upon ear No. 1.

Prof. Williams, of the Ohio Experiment Station, very wisely calls attention to the fact that the productive qualities of these two ears so crossed the one upon the other were not known. He practices the following method:

(2b) After selecting ears from the field as described above, a part, less than half, only of the grain from each ear is planted in rows as described in (1b). The remaining portion of grain of each ear is carefully saved. The crops from the several rows so planted indicate the productiveness and quality of the corresponding ears, and it is thus possible to tell which of these ears are more promising, and that portion of the grain from these ears which was saved, can now be planted in the blocks as described in (2a), thus crossing strong ears upon strong ears of known productiveness and quality. Ears from these crosses may be tested and crossed in like manner, and so on, as far as the breeder cares to carry on the work.

The value of such a system of cross-breeding is twofold:

(1) Cross-fertilizing of plants should result in increased vigor; and

(2) The bringing together of plants from ears selected for proven strong qualities ought to produce even greater vigor.

Do not be surprised or disappointed if the ears obtained immediately from this cross-pollenating are small or poorly filled.

IMPROVING QUALITY.

This has reference to changing the physical characteristics of the ear and kernel and the chemical composition of the kernel. Physical changes are brought about both by selection and by cross-fertilizing. At the present time selection is employed to accomplish chemical changes, and the chemical changes usually sought are in the starch, oil and protein content, depending, of course, upon whether the corn is grown for feeding purposes or for the starch factory.

The oil is obtained from the germ, and the quantity of oil depends upon the size and upon the quality—chiefly upon the size—of the germ.

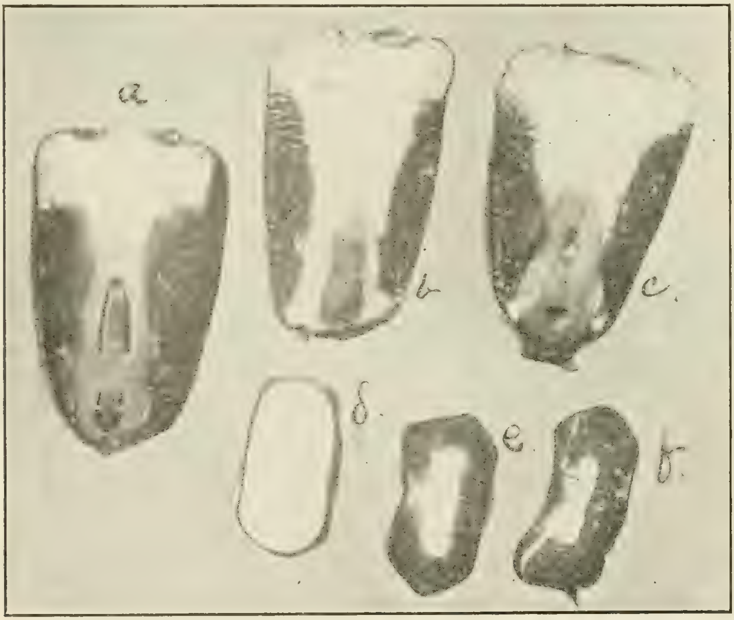


FIG. 19.—A study of the structure of the kernel of corn, showing the location of the germ with the embryo, and the distribution of the starch and the horny starch. The light portion is the starch. The very dark portion is the horny starch.
(a) Shows especially well the position and appearance of the embryo.
(d) Shows a cross section of a kernel like (b) just above the horny starch.
(e) Shows a cross section of the same kernel just below the upper end of the horny starch.
(f) Shows cross section of the same kernel at upper end of germ.
(c) Shows a larger proportion of horny starch than does (b).

Fig. 19 shows the structure of kernels of corn. The light portion of the kernel is the starch, the darkest portion is called the horny starch. The greater part of the protein comes from the horny starch; therefore, the greater the amount of horny starch, the greater the amount of protein.

If large oil content is sought, ears having kernels with large germs are selected for seed.

If large protein content is sought, the ears having kernels with a large amount of horny starch are selected for seed. It is claimed that in ears of the same breed, one has little difficulty in distinguishing with the eye, between kernels of high and kernels of low protein. By selecting kernels of high protein content for seed, the average content has been raised several per cent in experiments conducted for that purpose.

FIXING CHARACTER.

This is one of the most difficult things to accomplish, and it often requires years of careful work. It requires, too, that the breeder have very clearly in mind an ideal ear and that the ears he selects for seed conform very closely to this ideal.

One of the older and well-known breeds of corn is rather noted for the number of ears it produces untrue to type. One Michigan breed produces at the present time too great variation in style of ears and of kernels. There is good reason to believe, however, that this variation both of ear and kernel can be greatly lessened and quite readily, too.

On the other hand other well-known breeds, while they vary in size because of climate and soil condition, appear to produce ears remarkably constant in general appearance as regards shape of ear, and color and shape of kernel.

THE IDEAL OR PERFECT EAR.

It is not often found. It must possess certain physical qualities or characters:

1. Shape. In shape it should be cylindrical, or only slightly tapering. The very tapering ear is being bred away from. The rows should be straight, extending completely from butt to tip. See Figs. 1 and 2.
2. Color. The cobs should be red for yellow corn, white for white corn, and red or white for the white caps as now bred, but all red or all white. They should be white for flint corns.

There should be no kernels present indicating by color or shape that cross-pollenation from another breed had taken place.

3. Tips. The tips should be well covered with kernels of uniform size, the rows remaining unbroken to the end. The question as to whether the cob may not protrude slightly is an open one.
4. Butts. See Figs. 20 and 21. The butts should be well rounded as shown in Fig. 20. The shank, or ear stalk should equal about one-third the total diameter of the ear.
5. Kernels. The kernels should be wedge shaped, so that they shall fill completely all space between the circumference of the ear and the circumference of the cob. See Figs. 22 and 23. To examine kernels, remove two kernels side by side from the cob, one-third or one-half the distance from butt to tip, and lay them on some flat surface, germs up in the same relative position they occupied on the cob.
6. Length and circumference. At the present time the standards of the Michigan Corn Improvement Association are 8½ to 9½ inches for length and the circumference must not be more than 4-5 nor less than 3-4 the length of ear. The circumference is measured one-third the distance from butt to tip.

7. Per cent of grain to ear. The M. C. I. A. requires that 100 pounds of ears shall shell out eighty-eight pounds of grain, and individual ears shall shell in that proportion.

In corn judging, the following additional points are considered:

8. Uniformity. Ears may show that they belong to a particular breed, and yet lack in uniformity of appearance, just as a group of cows may leave no doubt as to what breed they belong, and yet may not be uniform in appearance of the group.

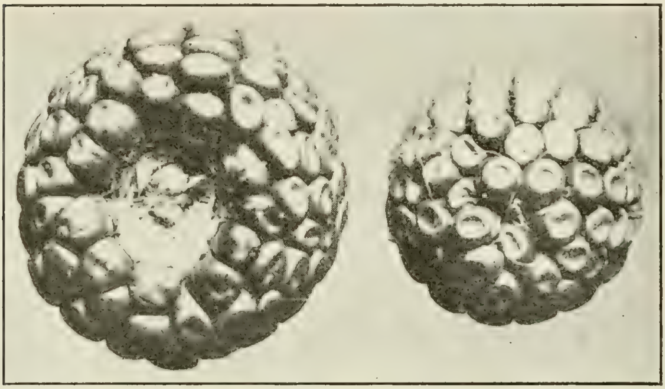


Fig. 20.—A very good butt and tip.

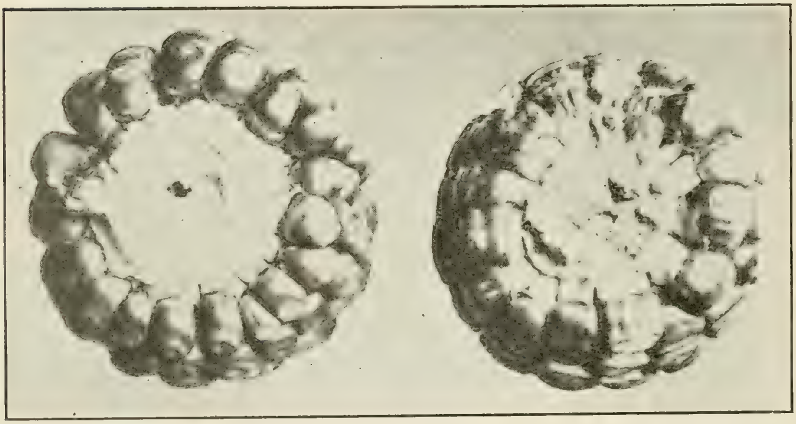


Fig. 21.—Two poor butts. The left one would be cut at least a half point, while the right one would be cut at least three-tenths of a point, under our rules for scoring.

9. Condition. This takes into account whether the corn is ripe, sound, free from disease, injury and dirt, is bright in color, and of apparently good vitality.

10. Uniformity of kernels. Two kernels are removed from each ear as described above and the pairs placed in rows for comparison. Every pair should look like every other pair in shape and size.

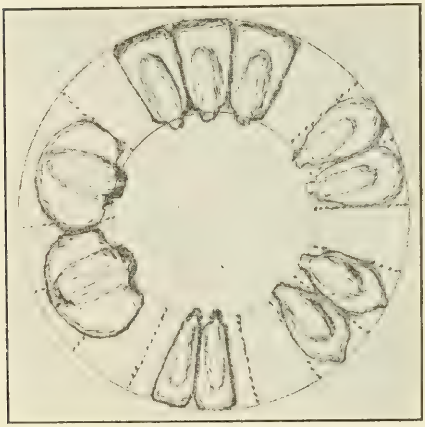


FIG. 22—A study of kernels.

The upper three kernels are well proportioned and occupy completely the space between the circumference of the ear and the circumference of the cob.

The upper right hand two kernels are poorly shaped and leave a lot of unoccupied space.

The lower right hand two kernels show how the white rice popcorn kernels occupy the space.

The lower two kernels are of the shoe-peg type.

The left two kernels show the relative shape and position of flint kernels as compared with the upper three dent kernels.

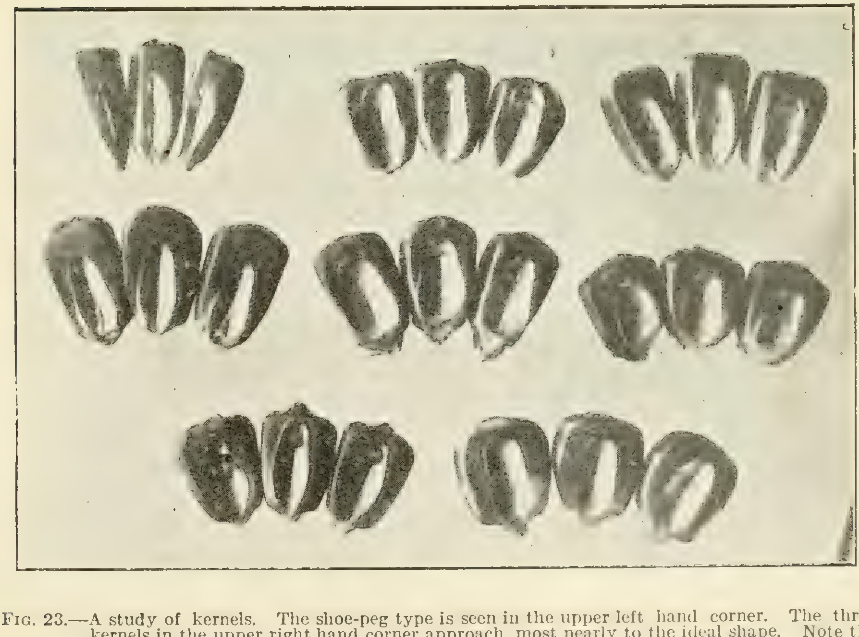


FIG. 23.—A study of kernels. The shoe-peg type is seen in the upper left hand corner. The three kernels in the upper right hand corner approach most nearly to the ideal shape. Note the unoccupied space because of the rounding edges in some of the cases.

CORN JUDGING OR SCORING.

In judging corn, ten ears are studied, their defects determined and charged against them. The score card is a convenient form for use in this work.

DENT CORN.

Score Card.

	Scale of points.	Standard.	Students' score.	Corrected score.
1	Uniformity of exhibit	10		
2	Shape of ear	5		
3	Color	10		
4	Condition	15		
5	Length of ear	10		
6	Circumference of ear	5		
7	Tips	5		
8	Butts	5		
9	Uniformity of kernels	5		
10	Shape of kernels	10		
11	Proportion of grain to ear	20		
	Total			

Date..........

Variety..........

Weight of five ears..........

Proportion of grain to ear..........

The following outline of things considered and rules for cuts is found convenient for beginners in corn judging.

OUTLINE FOR SCORING DENT CORN.

	Things to consider.	Rules for cuts.
1	Likeness between ears exhibited.	One point off for each odd ear.
2	Shape of ear. Arrangement and character of rows.	½ point off for each poorly shaped ear.
3	Freedom from cross-breeding.	10 points off for red cob in white ear or white cob in yellow ear. 1-5 point off for each mixed kernel with a maximum cut of 1 point per ear. A missing kernel counts as a mixed kernel.
4	Maturity, soundness, freedom from injury and dirt, brightness of color and vitality.	1½ points off for every diseased, injured, chaffy, immature or dirty ear.
5	Variation above 9½ in. and below 8½ in.	2 points off for every inch of excess or deficiency in length of ear.
6	Variation above 4-5 and below ¾ length of ear.	1 point off for every inch of excess or deficiency in circumference of ear.
7	Uniformity of tip kernels regularity of rows, completeness of covering.	¼ point off for every badly covered tip. ⅛ point off for every ¼ inch of exposed tip.
8	Manner of rounding out and quality of kernels.	½ point off for every uncovered butt. 3-10 point off when butt is covered but kernels are flat.
9	Likeness in shape.	½ point off for each set of kernels lacking in general uniformity of appearance.
10	Approach to ideal wedge shape.	1 point off for each set of poorly shaped kernels.
11	Per cent of grain to ear.	1 point off for each per cent short in weight of corn.

Standards:—Length of ear, 8½ to 9½ inches; circumference of ear, ¾ to 4-5 length of ear; per cent of grain to ear, 88.

SCORE CARD FOR WHITE-CAP DENT CORN.

The scale of points for white-cap corn is the same as that for white and yellow dents. The standards are the same, and the rules for cuts are the same except that the color of the cobs may be red or white, but must all be the same color in the same exhibit, and a cut of ten points is made when red and white cobs appear in the same exhibit.

SCORE CARD FOR FLINT CORN.

The following score card for flint corns has recently been adopted by the Michigan Corn Improvement Association:

SCORE CARD FOR FLINT CORNS.

	Scale of points.	Standard.	Students' score.	Corrected score.
1	Uniformity of exhibit	10		
2	Shape of ear	5		
3	Color	10		
4	Condition	10		
5	Tips	5		
6	Butts	5		
7	Length of ear	10		
8	Circumference of ear	5		
9	Open space	10		
10	Proportion of grain to ear	30		
	Total:	100		

Date..

Variety..

Length..

Circumference..

Proportion of grain in ear..

OUTLINE FOR SCORING FLINT CORNS.

	Things to consider.	Rule for cuts.
1	Likeness between ears exhibited.	1 point off for each odd ear.
2	Shape of ear. Arrangement and character of rows.	½ point off for each poorly shaped ear.
3	Freedom from cross-breeding.	10 points off for 1 red cob, 1-5 point off for each mixed kernel with a maximum of 1 point of cut per ear. An absent kernel is counted as a mixed kernel.
4	Maturity, soundness, freedom from injury and dirt, brightness of color and vitality.	1 point off for every diseased, injured, chaffy or immature bleached or dirty ear.
5	Uniformity of tip kernels, regularity of rows, completeness of covering.	¼ point off for every badly covered tip; ⅛ point off for every ¼ inch exposed cob.
6	Extent of exposure of butts.	1 point off for every inch of maximum exposure.
7	Variation in length beyond extremes allowed.	2 points off for every inch of excess or deficiency beyond the extremes allowed.
8	Variation in circumference beyond the extremes allowed.	1 point off for every inch of excess or deficiency in circumference of ear beyond the extremes allowed.
9	Open space between rows extending from butts toward tips.	1 point off for every inch of total space above ¾ inch in each of the several ears.
10	Per cent of grain to ear.	1½ points off for each per cent short in weight of corn.

Standards:—Length of ear, 10—12 in.; circumference of ear, 4½—5¼ in.; proportion of grain to ear, 84 per cent.

FERTILIZERS FOR CORN.

We are frequently asked to formulate a fertilizer for corn.

It should be remembered that the demands of the crop for artificial fertilizers cannot be the same for all cases. They will depend upon:

(1) The soil—its character, the amount of organic matter it contains, its tilth.

(2) The system of cropping that has been followed upon the soil; whether a rotation has been followed, or whether a continuous grain cropping process has been followed.

(3) The place occupied by the corn crop in the rotation.

A careful study of the following statements may make the matter of fertilizers more clear.

(1) According to Prof. Voorhees, of New Jersey, a fifty-bushel (100 crate or basket) crop of corn and the accompanying stalks will remove from the acre of soil on which they grow

80 pounds of nitrogen,
29 pounds of phosphoric acid, and
55 pounds of potash.

(2) However rich or poor the soil (in Michigan) it should furnish at least a part of these materials, and a well-cared for soil should furnish a very considerable part of them, or all of them.

(3) It is important that the young plants, as they begin to send down their roots and to throw out their leaves, be well supplied with nitrogen, phosphoric acid, and potash. The amounts the soil itself will be able to supply them will depend upon how well it has been previously handled, and the care with which it has been prepared for *this* year's crop. If there is not a natural supply at this time for the young plant, there should be an artificial one.

(4) A good supply of potash is needed throughout the growth of the plant, but its usefulness practically ceases when the final maturing of the grain begins.

(5) Nitrogen is required in increasing quantity during the growing season. It is applied artificially in less quantities than are phosphoric acid and potash, and especially so if the soil is well supplied with organic matter, because as the season advances the nitrogen of the organic matter is made available in increasing quantities, by the nitrifiers, for the growing crop.

An excess of nitrogen in the soil retards the maturing of the crop and may interfere with the development of the grain.

(6) The importance of phosphoric acid increases as the crop approaches maturity. *"Phosphoric acid forces or hastens maturity."*

(7) *Clover sod is the place for corn.* Some authorities state that even upon a well-manured clover sod some artificial fertilizers should be added.

(8) On the other hand some reputable farmers in Michigan who have made trials of commercial fertilizers upon manured clover sod, assert that no appreciable benefit was derived from this use of the fertilizers.

FURTHER FACTS AND THEORY.

A ton of fresh manure from the horse barn contains

10 pounds of nitrogen,
5.2 pounds phosphoric acid, and
9.5 pounds potash.

A ton of fresh manure from the cow barn contains

8.5 pounds nitrogen,
6 pounds phosphoric acid, and
9 pounds potash.

These are averages for well-fed animals and are abundantly conservative.

Manure from the sheep barn will be considerably richer than either of the above.

If well worked into and through the soil, these manures would probably give one-third and possibly more than one-third of the above constituents to the crop of the first year.

Remembering that the soil, if well managed, must always be able to furnish considerable quantities of the required plant foods, one may, with the above figures, estimate for himself what should be reasonable applications of barn yard manures.

COMMERCIAL FERTILIZERS.

The use of commercial fertilizers is much resorted to in the east and to some extent in Michigan. The amounts applied seem extravagant in many cases; for frequently they are equal to and sometimes exceed the quantities actually removed from the soil by the crop. This is seldom true in the application of nitrogen, but it is true in the case of phosphoric acid and potash. The following table contains some classified information which may be helpful.

	Nitrogen.	Available Phos. acid.	Potash.
Pounds of material removed by a 50 bu. (100 basket) crop of corn including stalks	80 lbs.	29 lbs.	55 lbs.
The proportions of materials recommended by one authority for a good fertilizer	2 per cent.	6 per cent.	7 per cent.
600 lbs of this fertilizer would add to the soil	12 lbs.	36 lbs.	42 lbs.
An eastern authority recommends an application of commercial fertilizer that adds to each acre (when no manure is added)	15—19 lbs.	69—99 lbs.	50—65 lbs.
This is suggested by an eastern authority where a dressing of manure has already been applied	9—11 lbs.	62—80 lbs.	38—50 lbs.
And this from Oregon	15—20 lbs.	30—60 lbs.	40—80 lbs.
100 lbs sodium nitrate furnishes	15½—16¾ lbs.	....	....
100 lbs. tankage furnishes	7½—9 lbs.	7—9 lbs.	....
100 lbs. ammonium sulphate furnishes	19¾—20¾ lbs.	....	....
100 lbs. muriate potash furnishes	....	....	50 lbs.
100 lbs. sulphate of potash furnishes	....	....	50 lbs.
100 lbs. South Carolina acid phosphate furnishes	....	13—14½ lbs	....
100 lbs. Florida acid phosphate furnishes	....	13—16 lbs.	....

ANNUAL REPORT OF THE SOUTH HAVEN SUB-STATION FOR 1908.

Special Bulletin No. 48.

The following report upon the work of the South Haven sub-station for the year 1908 is herewith respectfully submitted:

The past season has, more than any other for some time, demonstrated the advisability of using modern methods in fruit plantations. The value of spraying at exactly the right time was markedly shown in orchards where the first sprayings were done before the wet weather set in at blossoming time, while orchards that were well cultivated passed through the dry time in good shape. The warm fall hastened the ripening of winter fruits and has also caused them to keep poorly in common storage. Fruit generally was well colored this year, the coloring undoubtedly being caused by the dry, clear, sunny days we had during the past summer.

STRAWBERRIES.

The strawberry season was good and the weather conditions favored an excellent growth of plants. The crop was also very satisfactory in most sections.

The strawberry, being a surface feeder, is very susceptible to various soil conditions. Therefore, variety testing must to a great extent be local. While loamy soils are natural strawberry soils, we have varieties that are quite well adapted to the lighter soils. Generally speaking, the varieties may be put into three classes with reference to soils. The soft, irregular, wedge-shaped, and often insipid varieties of which Haverland is probably the most popular, do quite well on light soils. The Warfield class, which is of rather small leaf and medium-sized berry, do well on moderately heavy soils. The highest quality and handsomest red berries, which are never over productive, such as Marshall, need the richest loamy soils.

A variety will vary much in different soils. Its behavior in one soil may be so entirely different than in another as to change its size, quality, color and productiveness. Many of our supposedly new varieties are undoubtedly old varieties with variations caused by soil differences.

Our usual leader in productiveness, Bederwood, dropped back to seventh place this year. This was due in part to the less favorable soil conditions it was grown in. The Buster, a new variety, was most productive. The other productive varieties ranged as follows: Gersonda, Pineapple, Aroma, Warfield, Brandywine, Bederwood, Sample, etc.

Of the older varieties Aroma, Brandywine, Sample and Gersonda did very well and bore large fine fruit. Warfield and Senator Dunlap were, as usual, quite productive but the fruit was unusually small. Gandy was still among the best of the late varieties, having a much handsomer appearance than the Nettie and Midnight. It is also more firm than those varieties.

The following varieties of recent introduction were fruited at the station this year:

Abington (Perfect). A good healthy plant-maker with large dark foliage. The fruit is large, regular, roundish-conical, (typical strawberry shape). The flavor is mild acid, good; and the color is bright, glossy red, with red flesh. Being firm, it is a good shipper. Only moderately productive here. It would undoubtedly be worthy of a trial in a rich, strong soil. Mid-season.

Advance (Perfect). Foliage appears to be somewhat tender and subject to the attack of the rust. The leaves are not over large and are light colored. As a plant-maker it is good. The berries are long conical, being similar in shape to the Haverland, and also have a tendency to green tips. The berries are not held up from the ground well. Flavor mild sub-acid. Moderately firm and only fairly productive. Not promising here.

Beavers (Perfect). A western berry whose foliage is somewhat small, and not very thrifty. Somewhat subject to rust. Not very good as a plant-maker. Fruit medium small, dark, glossy red. The surface is firm and smooth, with seeds that stand out quite prominently. Flavor mild. Not promising.

Beidler (Imperfect). A good plant-maker. Foliage light green. Plants quite thrifty and upright growers. Fruit dark glossy red, somewhat irregular, wedge-shaped. The fruit is held up quite well but does not color very evenly. The seeds are large and somewhat prominent. A moderate bearer here. Flavor mild, acid. Texture firm, making it a good shipper. Would probably do well in heavy soils.

Ben Davis (Perfect). Foliage rather small. Plants do not seem to stand drought well. Berry roundish, smooth, dark red, with seeds standing out prominently. A good plant-maker. Texture firm.

Boston Prize (Imperfect). Plants healthy and thrifty. A good plant-maker. Berry is irregular, conical, moderately firm and of medium size. Color light red. Flavor mild, sub-acid. Quite productive. Mid-season. The fruit is too small and irregular to make it promising.

Buster (Imperfect). Again this variety has shown itself worthy of a trial by strawberry growers. The foliage is very thrifty. Very good plant-maker. The fruit stems are short and thick, and the berries lie under the leaves. Color bright red. Texture moderately firm. Flavor mild and pleasant. Last year it was the most productive of the new varieties and this year it was the most productive variety in the patch. Mid-season to late, hanging on well to the end of the season. Fruit medium large. Form short conical, somewhat irregular.

Climax (Perfect). A good plant-maker. The foliage sets close to the ground and is somewhat small. Berries are firm, medium large, irregular round in shape. The color is glossy red. Flesh red. Flavor mild, acid. Productive. Proves to be a good early variety.

Chipman (Perfect). Originated in Delaware. A berry of the Uncle Jim type. Foliage very heavy. A good plant-maker. The berry is large, irregular, conical in shape and furrowed like Uncle Jim. It is very much like Uncle Jim, but bore much better than that variety this year.

Dixie Belle (Imperfect). Fruit medium sized. Color light red with dark colored seeds. Flavor mild and of fair quality. The core of the fruit is somewhat transparent. Foliage light green, moderately vigorous and somewhat subject to rust. Rather a shy bearer. Not very promising.

Ekey (Perfect). A very good plant-maker. Foliage thrifty and stands up well. The berries are long, irregular, conical, generally necked. Color, dark glossy red. Flavor mild, acid, pleasant. We had it in a lighter soil this year than last and it did not bear as well. Season medium early and rather short.

Elma (Perfect). Berry large, roundish conical. Glossy red, with seeds a little darker than berry. Flavor mild, sub-acid. Quality very good. Later than Gandy and darker than Nettie or Midnight. Calyx small. The plants are large and thrifty, making a good row. On rich soil it would prove a good late variety.

Enormous (Imperfect). From our results this year this variety is wrongly named as neither the fruit, foliage nor yield was "enormous." The rather small plants are only moderately vigorous. The medium-sized fruit is roundish wedge-shaped, with a blunt and rather indented apex. Color glossy red. Firm. Flavor rather acid. Fair in productiveness.

Florella (Imperfect). Berries generally large, smooth, wedge-shaped. Seeds small and somewhat numerous. Firm. Foliage thrifty, dark-green and stands up well. Good plant-maker. Flavor very pleasant at first but the after taste is bitter. Rather light yield.

4 F (Perfect). Healthy, light green foliage. A good plant-maker. Berry medium large, wedge-shaped, sometimes necked. Moderately firm. Flavor mild sub-acid, pleasant. Of the Uncle Jim type, but in general is no improvement over it. Bore well this year.

Good Luck (Perfect). Medium-sized fruit of a red color, irregular, broad wedge-shaped, and firm in texture. Seeds somewhat numerous. Quality good, the flavor being pleasant, mild and sub-acid. Plants are healthy and vigorous and make a good row. Quite productive. Mid-season. Promising.

Hummer (Perfect). A large conical to wedge-shaped berry, sometimes necked. Color bright red, usually with a white tip and underside. Plants thrifty. Medium early. Has not proved productive enough to be desirable here.

Morning Star (Perfect). Fruit of deep, glossy red color. Rather small in size and of acid flavor. Quality fairly good. A good plant-maker. Foliage rather small and light in color. Only moderately productive. An early variety but not likely to supersede the old early varieties we have now.

Nimrod (Perfect). Fruit medium large; dark glossy red in color. Very irregular in shape, being mostly broad wedge-shaped. Moderately firm. Foliage healthy, dark green, and large. A good plant-maker. Bore quite well this year. Would be promising as a mid-season berry if it were not so irregular in shape.

Pineapple (Perfect). A variety much like the Uncle Jim. Bore very well this year. Sent out by W. N. Scarff, New Carlisle, Ohio.

Pride of Michigan, Kellogg's (Perfect). There are two varieties of this name, the other one being introduced by O. A. D. Baldwin of Bridgeman, Mich. The variety introduced by R. M. Kellogg Co., of Three Rivers, Mich., looks a great deal like Uncle Jim in both plant and berry, and does not appear to be any improvement on that variety. Fruited for the first time this year.

Red Bird (Perfect). Fruit of medium size, roundish conical in form, with a blunt apex. Color, glossy red with solid red flesh. Foliage light green in color, quite thrifty. Moderately good plant-maker. Berry smooth and of good appearance. May prove good as a medium early variety. Moderately productive.

Schrieber (Perfect). Of the Uncle Jim type and, does not show any improvement on that variety.

Vick's Uncle Joe (Perfect). Thrifty dark green foliage. Moderate plant-makers. Fruit stems rather long, and do not hold the fruit up well. Fruit irregular, wedge-shaped, sometimes necked. Glossy red. Moderately firm. Flavor mild, sub-acid, very pleasant. Not very productive. Season medium to late.

Virginia (Imperfect). A moderate plant-maker. Foliage medium-sized and moderately thrifty. Fruit medium to large, roundish and with seeds quite sunken. Color glossy red. A moderate bearer. Early. Not promising.

Chesapeake (Perfect). This variety was received here two years ago. Owing to the poor condition of the plants at the time of setting, they did not do well. This year the plants that remain bore well. They are thrifty, free from rust and make a good row. The berry is large, glossy red with beautiful yellow seeds, evenly placed. The form is smooth, even and wedge-shaped. The berry is very handsome, with red flesh. Season is about that of Gandy. The stems hold the fruit up well. Should this variety show up to the promise of the few plants we had this year, it will be a valuable addition to the standard list.

Lincoln Seedling (Perfect). Foliage subject to rust and not very healthy. Good plant-makers. Berries dark glossy red, long, wedge-shaped, of medium size, and somewhat soft in texture. Medium late. It bore quite well this year.

The following seedlings were received this spring from Henry J. Schild of Ionia, Michigan: Berlin, Diamond, Ozark, Red Prolific, Bower, Ionia, Plumb-Bob, Red Dawn, Ruby King, Black Beauty, Grand Marie, Red June, James Sons, Commissioner, Brilliant, July, Evening Star, American Beauty, Seek, Governor Rollins, St. Louis, Ionia Black, Ionia Market and M. O. 14.

A few plants of each variety were allowed to bear some fruit. All varieties showed up well as far as the few fruits were concerned. Many of them had a dark, glossy red color which will make them valuable for market. All showed some promise and individual merit; will be reported on next year when we can give them a better test.

The Cardinal, Kittie Rice and Stevens Late Champion do not do as well here as in other localities.

The following standard varieties do well here. Excelsior, August Luther, Senator Dunlap, Warfield, Brandywine, Gersonda, Sample, Aroma, Uncle Jim or Dornan, Parson's Beauty, Gandy, Clyde and Bederwood. The Clyde and Bederwood are only commended on account of their bearing qualities. Their light color, soft texture, and quality are against them as high-class market berries. The plants of Dunlap and Warfield are naturally small, but they always make good matted rows. The Gersonda makes a very good row and bears well.

It should be more commonly used. Its fruit is of a good size. Parson's Beauty is also prolific and makes a good berry for canning. Sample and Aroma always go together well. Aroma is a very good fertilizer for the Sample. Brandywine has a large calyx or hull, and for that reason fills the boxes quickly, but it does not make a nice looking package. It is also a little dull in color. Uncle Jim is an excellent berry for a light soil. The berry is large and attractive; the foliage healthy and thrifty. The flavor is mild and to some is of poor quality, while others like it. Marshall is excellent in texture, color and flavor, but is a poor plant-maker and needs the richest soil to bring it to perfection.

GOOSEBERRIES.

Since the freeze destroyed most of the peach trees in this section, renewed interest has shown itself in the small fruits, especially in the gooseberry and currant. The greatest hindrance to gooseberry growing is the fungous diseases, mainly mildew. For this reason the gooseberry should be grown on a fairly moist, but naturally drained soil. The bushes, also, should not be allowed to grow too dense and every year they should be thinned out by pruning so as to let the sun and air into the center of the bush. With these precautions and spraying about every ten days until the fruit is ripe, with liver of sulfur at the rate of three ounces to ten gallons of water, the mildew can be kept in check. The soil should be well tilled from early spring until August, when it is advisable to sow some oats for a cover crop. Care should be taken in the spring to cut out all canes that have the cane borer in them. It is also well to renew the canes every three years.

Downing is undoubtedly grown more than any other variety. It is a good healthy grower and always bears well of moderately large fruit. Chautauqua is a prominent English variety but during the last few years the Columbus has done better here. Columbus is an American seedling of the English gooseberry. Both the Chautauqua and Columbus bear large handsome green berries of the best quality. None of the English varieties, however, bear as well as the American sorts, but they excel the American varieties in size and quality. Industry is a red English variety that always does well. Its color and hairiness somewhat detract from its appearance in the market. It is the best red English sort. Lancashire Lad, a light pink variety, is a little larger than Industry and not so hairy, but it is not as productive. Young bushes of Portage and Crown Bob show up well. Portage is of the European species and is claimed to be free from mildew. The bush is compact and of a healthy appearance. The fruit is large and handsome, of a creamy green color, and as it seems to bear well, it is promising. The foliage of Crown Bob is not as healthy and the berry is not as large.

Houghton is an old standard American variety with rather small fruit, but always plenty of it. Its color is reddish brown which detracts from its market value, but the quality is good. The habit of growth is rather sprawling and spreading. It is practically free from mildew and easy of cultivation. Josselyn is larger than Houghton and a little earlier but it does not bear as well. Pale Red is about the size of Houghton, a little darker in color and of better quality. It is not, however, as sturdy a grower, nor as prolific.

Tree, named for its upright, tree-like growth, is a very late variety. Its fruit ripens after all of the other varieties are gone. The bushes are thrifty and are comparatively free from mildew. The foliage is not as dense as on other varieties. The fruit is of medium size and of fairly good quality when fully ripe. It is always a moderate to good bearer.

Pearl is a cross between the Downing and an English variety. It greatly resembles the Downing but the fruit is more of a creamy color and the bushes slightly more spreading. However, it is in no way superior to its parent.

CURRANTS.

The cultural methods for the currant are very similar to those for the gooseberry. Special care should be taken to control the currant worm. Early applications of Bordeaux mixture with about four ounces of Paris green to fifty gallons of mixture will control them.

The London Market is undoubtedly the best currant to grow in Michigan. It is of good size, the berry being nearly the size of the Cherry currant. It always bears well and the bushes are very healthy.

Of the older Cherry varieties, Fay is the best. It bears well when not attacked by borers and is a good currant for a fancy trade, but for a general market the London Market may prove the better.

Red Dutch and Victoria are good varieties but they do not show up as well as the London. Victoria is very free from the borer and in that way is better than the London Market.

Cherry, Comet, Lakewood, North Star, Ruby Castle, Select and Wilder are all currants of good size and appearance, but they either lack in productiveness, vigor of bush, or are subject to borers. The Wilder, in some years does very well, but as a general rule it does not do as well as the favorites.

Pomona, a comparatively new kind, lacks in vigor and cannot be recommended for Michigan.

Perfection, a new variety which has been highly spoken of, bore some fruit this year which was very large and of handsome appearance. The size of the berry is a little larger than that of the Fay. The bushes are very healthy and thrifty and showed themselves as being very prolific. The bunches were quite long and compact. Of the varieties set out last year, this one showed up the best.

Champion and Wales are the best black currants, and White Dutch is the best white one.

DEWBERRIES.

Two varieties of dewberries were fruited this year. The vines were rather hard to get started during the first year but after getting them established, they grew vigorously.

Austin, sometimes called the "Texas" dewberry, is a very thrifty and rampant grower. The foliage is large, and of a healthy dark green. The berry is medium large, of good dark color, and well-shaped. It is a little soft in texture and in flavor a mild acid. Several days earlier than the Premo. Moderately productive.

Premo. The growth is not as thrifty as that of the Austin. The berries are not as large and are more irregular in shape. Firmer in texture and more acid in flavor.

RASPBERRIES.

The crop of raspberries was generally good. Some varieties of the red raspberries, such as the Loudon, Miller, Early King, Thompson and Marlboro, were so seriously injured by the freeze of October tenth, 1906, that many of the plants failed to come up, leaving the rows in poor condition.

In the following report of the varieties, R, will denote red raspberries, B, black raspberries and P, purple raspberries.

Brilliant (*R*). A very thrifty grower, making a large compact bush. Canes are quite tall and the foliage is very healthy. The fruit is of medium size, small lobed, firm, and altho somewhat seedy, the quality is good and the berry of good color. Quite productive and lasts thru a long season. The size of the fruit is its only bad feature. It outclasses all other varieties in productiveness. Season medium to late.

Black Diamond (B). Bushes healthy and vigorous, and moderately productive. Berries medium in size, lobes irregular. Color glossy black with the exception of a slight bloom. Firm enough to be a good shipper, and the flavor is very good, making this variety one of the best in quality of the blackcaps. A good variety.

Cardinal (P). A very upright, compact grower. A solid row of plants gives the appearance of a good hedge. About as productive as the Columbian, but the fruit is not as large. The canes are more hardy than most other varieties. The fruit has considerably more bloom and is firmer than Columbian. For shipping purposes it is the best purplecap we have.

Columbian (P). The best known purplecap. Very vigorous and productive. The berries are large, somewhat soft and of good quality. Unexcelled for canning and home use. The berries have more bloom than Haymaker, and crumble easier than Cardinal. The most productive variety of its class.

Conrath (B). Only a fair bearer and moderately thrifty. Does not stand dry weather well. Fruit medium-sized and often ill-shaped. Season medium early. Not promising.

Cumberland (B). Still holds its reputation of being the best midseason blackcap. Somewhat subject to anthracnose, but this can be controlled by proper spraying. Always productive.

Cuthbert (R). The best red raspberry. Grown more than all other varieties together. It deserves the place it holds.

Early King (R). The plants not good growers nor vigorous. Berry of medium size, color and quality. Not productive. Not promising as a commercial variety. Season early.

Eaton Red (R). A seedling originating in Indiana. A healthy but not vigorous grower, and the canes do not attain any great height. One of the earliest varieties on trial and also has fruit ripening thru to the end of the raspberry season, owing to the bearing of the new canes. The fruit is large, with large lobes, and is fully colored before it is ripe. Even when ripe they have a tendency to crumble. The color is very dark red, nearly purple, and the flavor is very pleasant, somewhat like that of the purplecaps. The color and quality of the fruit suggest that there might be some crossing of the purplecap in this variety. It is very prolific and is very promising, especially for a fancy home market.

Eureka (B). A fair grower; foliage large, dark and healthy. The berry is of medium size, somewhat soft, and of good quality, with lobes of medium size. The tops of the lobes are a dark glossy black, while the "valleys" or spaces between the lobes are full of whitish bloom. Productive. Promising as an early blackcap.

Gregg (B). An old standard variety whose place is being taken by other varieties. The canes make a strong growth and the fruit is of good size and quality, but at the last it gets small and ill-shaped. Although somewhat lacking in hardiness it is generally quite productive. Considerable bloom. Ripens before Cumberland.

Haymaker (P). The largest of the purplecaps and of darker color than the other varieties. The fruit crumbles very easily. The quality is not as good as that of the other varities. The growth is somewhat like that of Cardinal but more spreading, and it seems fully as productive. It seems a little hardier than Columbian.

Kansas (B). The best early blackcap on trial. The growth is vigorous and healthy. The fruit is of good size, appearance and quality and is a good shipper, but is inclined to run small at the end of the season. It goes well with Cumberland, as it is nearly thru when that variety begins to ripen.

Loudon (R). A popular variety in many places but does not do well here. The plants are poor growers, only fairly productive and quite subject to crown-gall. The berries are of medium size and quality, of good color and roundish-conical in shape. The lobes are of medium size and hang together well. Cannot be recommended where Cuthbert can be grown.

Marlboro (R). A berry of large size, high quality and appearance; roundish, firm and a good shipper. The plants are only fairly vigorous and are quite subject to disease. Moderately productive. The plant does not do well enough to recommend it for general planting, although in some sections it is still a favorite.

Miller (R). Another poor grower with weak looking plants. Early, and looks a great deal like the Early King.

Mills (B). A fairly good grower. Berries medium to small with considerable bloom and of fairly good quality. Quite seedy. Fairly productive.

Phoenix (R). A thrifty, healthy grower. The canes are rather short but bear well. The berry is of good size, and the color is something like that of Cuthbert. Form round, firm and a good shipper. Ripens about the same time as Cuthbert but has a longer season. In quality not as good as Cuthbert. Productive. A good commercial berry, in this respect probably equal to Cuthbert, but not as good for home use.

BLACKBERRIES.

Next in the succession of fruit is the blackberry, which should be treated much like the black raspberry. The old canes should be taken out after fruiting each summer and in the spring all but six of the new canes should be removed. As size is very important in marketing this fruit, the remaining canes should be well pruned back to produce large fruit. During the summer the growing canes should be kept cut back to about three feet in height to produce stout, low-branching plants. The crop was generally very good this year.

Blowers. Fruited for the first time this year. A thrifty grower, quite hardy and with a spreading habit. The berries are roundish, medium in size, and acid in flavor. Moderately productive. Season medium to late.

Early Harvest. Compact, upright grower. Does not sucker much. Berry of medium size and fair appearance. Only moderately hardy, but quite productive. Not quite as early as Early King but its season is longer. Its earliness is its only attractive feature.

Early King. The earliest blackberry on trial. The fruit is of good size until the end of the picking, when it gets small. Moderately productive. A little hardier than Early Harvest. The canes are only moderate growers, with light colored foliage. Does well as an early variety.

Eldorado. A very hardy and thrifty variety. The fruit is of a very good size and quality and has a handsome appearance. Generally quite productive, altho it bore rather lightly this year. It should be grown to take the place of Snyder. Medium early, ripening just before Snyder.

Eric. A midseason berry of very good quality. The fruit is very large and attractive but somewhat soft in texture. Quite hardy. Not productive enough for commercial purposes but very good for home use.

Mersereau. A moderate growing, hardy, spreading variety. The fruit is of medium size and attractive, with a hard core. Flavor mild, acid and pleasant. Its season is rather short but it makes a very good late variety. Productive.

Rathbun. The last two years has shown this to be the very best berry on trial. The fruit is large and very much like Wilson in size, form and quality.- Its season is also about the same. It is a very thrifty grower and very productive. It is hardy and does not need laying down in this climate as the Wilson does. By far the best blackberry in our patch and well worthy of taking the place of the Wilson.

Ohmer. A very large, late variety of good quality and appearance. The bush is quite thrifty. If it were not shy in bearing, it would make an ideal late variety.

Snyder. A well-known, very hardy variety. The canes are very vigorous and very productive. The fruit is small, but of good quality. On account of its size it should not be grown except where other varieties are too tender.

Ward. A thrifty grower and very hardy and productive. The fruit is large and of handsome appearance. Firm enough for shipping, but has no core to speak of. The flavor is slightly more acid than that of Mersereau. A very promising late variety, showing up better than any other.

Two years ago several plants of the Himalaya blackberry were sent here by the U. S. Department of Agriculture. Two of them survived and bore fruit this year. This variety was grown by Luther Burbank from seeds sent him by a friend who got them from the Himalaya mountains. It is a very rampant grower, exceeding anything we have on trial. Their growth is very spreading or trailing. For cultural purposes it would have to be put on trellises. The fruit ripens very late and is rather small and ill-shaped. The two vines were not alike, one ripening about two weeks before the other. Both seemed very hardy. Their flavor is very acid and they have a hard core. The earlier one had the best fruit, and its large leaves were of a light color. It was also the thriftiest grower of the two. They will undoubtedly be of no value here but may be desirable where extreme hardiness is desired.

CHERRIES.

Of all of the tree fruits the cherry is probably least grown in Michigan. The sour kinds are practically the only ones grown except by a few specialists. Richmond and Montmorency are the principal varieties grown. For a reliable, annual bearer, Montmorency is hard to excel. The fruit is larger, firmer, and of better quality than the Richmond and it is very little subject to disease. In short, what the Cuthbert is to the raspberries, the Bartlett to the pears, and Concord to the grapes, the Montmorency is to the cherries.

The Dyehouse is worthy of favorable mention as an early cherry. The tree is not quite as large as the Richmond but with us it has proved more productive. Ripens several days before that variety. In firmness it equals Richmond and in quality is perhaps a little better. As an early cherry to precede the Richmond, it can be recommended.

The Dukes can only be grown for home use in this part of the state. They generally ripen so unevenly and rot so easily when nearly ripe that the expense of picking would be too great to allow anything for profit.

The Montrueil is the most prolific variety, but is quite subject to rot. The fruit is of good size, color and quality, and undoubtedly it is the most profitable Duke on trial. The Olivet is also a very good variety, altho not quite as productive as the Montrueil. It ripens more evenly and is less subject to rot. It is more vigorous and when grown in a light soil where its growth is kept in check, it would undoubtedly equal the Montrueil in productiveness. The fruit is equally as handsome and is good both for dessert purposes and for canning. Except in productiveness, it is the best variety we have on trial.

Magnifique is a good late cherry, ripening about the same time as the English Morello. The fruit is yellow, nearly covered with red. It is smaller than Montrueil and not as good in quality. The trees are not very large but are quite prolific. A good variety for home use.

SWEET CHERRIES.

Mainly due to the birds and their cracking when nearly ripe, the sweet cherries are not much grown. We find only two varieties, the Napoleon and the Windsor, worthy of any extensive growth.

Napoleon is a yellow cherry with a slight red cheek. Its form is somewhat globular, and its quality is moderately good. The tree is vigorous and bears well except that in some seasons it rots badly.

Windsor is later than Napoleon, and of better quality and appearance. It is dark, handsome, red, or liver color, and short, heart-shaped in form. The size is generally good but some seasons it is only medium. It often cracks badly when nearly ripe. The tree is productive and a moderately vigorous bearer. For a fancy, sweet cherry, this variety is the most promising.

The large early yellow sweet, Governor Wood, is good to set for the birds. They generally get all of the crop of this variety.

Schmidt's Bigarreau is good for the size, attractiveness and quality. It is of a dark red color with flesh the same, and is very large. The tree, however, lacks productiveness with us and would only be suitable for home use. It is a very thrifty grower and a light soil would undoubtedly increase its productiveness.

A light sandy soil well elevated is best for all sweet cherries as it lessens their liability to rot and crack.

PLUMS.

The plum crop was generally quite good. Due to the unfavorable weather at the time of the early sprayings, which usually are effective in controlling the curculio, there was considerable fruit stung by this insect; the dry weather later, however, kept the rot in check. The following varieties bore this year:

Archduke. A large, firm, dark blue plum ripening early in September. Not being as productive, thrifty or large as the Grand Duke, it should be discarded in favor of that variety, unless earlier fruit is wished.

Black Diamond. This is of the large, dark blue type with firm fruit of handsome appearance. The tree is quite thrifty and bears well. One of the earliest ripening varieties of the large blue plums. Good for market, but not good for dessert purposes, as it is too acid. Good for cooking. Has considerable bloom.

Bradshaw. Probably the most popular purple plum. Of good size, moderately firm, with good flavor. Quite productive. Ripens August 15. Deserves the popularity it has. Its only drawbacks are that it is rather late in bearing and the fruit is subject to rot.

Burbank. One of the best Japanese plums. Large, roundish, yellow nearly covered with an attractive red; quality good. The tree is of a very spreading habit and is quite productive. Not quite as hardy as Abundance, but seems to be more productive. An ideal market and dessert plum. Rather tender for canning, as it does not hold together. Season later than Abundance.

Coe (Golden). A large, late plum of the Yellow Egg type. Quality very good, being much like that of the Green Gage plums. The trees are vigorous but not very fast growers. It has again shown that it is a good late plum.

Fellenberg. The largest of the prune type. The fruit is of good quality and is desirable for market and canning purposes. The tree is of a low, spreading habit, vigorous and productive. Probably the best of the prune type on trial.

Field. Similar to Bradshaw in shape, flavor and color. In size it is a little smaller and the "neck" is less marked. Ripens about the same time, but being no improvement on that popular variety, it cannot be especially recommended.

Grand Duke. The best large, blue plum and one of the best of the Domestica plums grown here. Its size, color, attractiveness and quality make it a good market plum. The tree is quite vigorous and is always quite productive. Ripens about August 3.

Lombard. Probably the best known plum grown, its only drawback being that it is subject to the attack of rot and leaf blight. It is always productive and hardy, and is a favorite with canners, as when green it can be canned as Green Gage, while the ripe ones can be put up under their own name. For market the large, blue varieties are more suitable.

Middleburg. A very late ripening plum. In color and size it greatly resembles Lombard. The tree is vigorous and quite productive. It does not color up as much as the Lombard. Quite free from rot. Good as a late plum.

October Purple. The latest ripening variety on trial. The fruit is of large size, roundish in form with a blue color verging on purple, marked with numerous whitish spots. Fruit firm, of good quality, with a yellow, juicy flesh. Pit small, cling. A promising late variety for both home use and market. The trees are very thrifty, upright growers. Bore well this year on young trees. Ripens during the last week in September.

Stark (Gage). A productive variety of the Gage type. Quality equal to the best. The tree is vigorous and hardy. Like all Gages, it rots very easily when nearly ripe, and does not hold up well for shipping. Very good for home use and canning. For market it must be picked somewhat green. Ripens during the latter part of August.

Spaulding. Very similar to Stark Gage but is not quite as good quality. Ripens at the same time.

Shropshire. The best of the Damsons. The tree is vigorous but not a fast grower and the branches are slender. Productive. The fruit is small, dark blue, firm and little injured by rot and the curculio. Very good for canning and preserving, and sold only for that purpose. Ripens in September.

Victoria. A moderately large plum of a yellow color overlaid with light red. The tree is very vigorous and productive. The fruit is moderately firm, but with tender skin. Good quality. More subject to the rot than any other variety on trial and as the color is too light for market purposes, it has little value as a commercial sort. Ripens about August 20.

Simpson. A medium small, yellow plum ripening about the twentieth of August. Firm in texture, of good quality, and nearly free-stone. It bore a full crop this year, but in the past has been only fairly productive. The tree is moderately vigorous with a slender upright growth. Of no promise here.

PEARS.

The condition and value of the pear crop varied greatly this year in proportion to the amount of spraying done and the time of application. A few days variation in the time of the first application of Bordeaux made a great difference. Where the fruit was held on by proper care, the crop was good, all of the standard varieties bearing well.

Bartlett, the king of pears, bore very well and the crop was very fine. The popular Kieffer, the Ben Davis of pears, bore so heavily that in most cases they were so small that they were only fit for the cider mill. Thinning would have done much to enlarge the fruit and also put the trees in better shape for next year's crop. It was hard to grow perfect specimens of that good quality pear, the Flemish Beauty, which is so susceptible to the scab. Only on the high, dry clay knolls, where the conditions are not favorable for the scab, can this variety be grown with any degree of success. Howell and Anjou bore good crops of fine, large fruit. It takes Anjou some time to get into bearing and the fruit is very likely to drop. Otherwise it is a very good pear, having all the essentials for a market variety. Howell is one of the favorite varieties for market and dessert use. The fruit ripens about September 15, and is firm, handsome and smooth. It varies in quality; in some seasons being better than in others. The tree is vigorous and prolific. Souvenir du Congres is an excellent, large, attractive, market pear. On account of its size it brings good prices, especially for fruit-stand trade. The tree is vigorous and productive. The quality of the fruit varies with the seasons, some years being of quite high quality and others somewhat coarse and watery.

The following varieties also gave good results this year:

Bartlett-Seckel. The size of the fruit is between that of the Bartlett and Seckel, with Bartlett shape, and a color somewhat like that of the Seckel, only of a lighter red. Smooth and very attractive. Flavor varies, some seasons of a very good quality, but in occasional seasons is of a puckery taste. At no time is it of as good quality as the Seckel. Not very productive thus far.

Conference. Of the Bosc size and shape. The color is yellowish green, covered with a sprinkling of russet. A smooth, handsome fruit. The flavor is very good and about equal to that of the Bosc. The flesh often has a slight, rich pink tint, giving it a very attractive appearance. The tree is not as thrifty as the Bosc but it is about as productive and comes into bearing a little earlier. Ripens a few days before that variety. A worthy companion of the Bosc.

Drouard. A large, light green winter pear. Regular pyriform in shape with a thick neck. Form is very regular and smooth. Evenly dotted with brownish dots. The only pear that kept until December 1 this year. Very firm. A good keeper, being good until March 1. Quality quite good. Vigorous and productive.

Elizabeth. A medium to small pear of the Seckel shape. Color is yellow covered with a bright reddish brown cheek. Flesh firm. Flavor is very good, being sweet and pleasant. Tree vigorous, a thrifty grower and very productive. Ripens about August 20. Good for market or home use.

Fitzwater. Medium size, yellowish green, well covered with spots of russet. Not an attractive looking fruit. Flavor very pleasant, sugary. The tree is rather a low grower and is moderately productive. Ripens about October 10.

Garber. Of the Kieffer type. Fruit of good size. The tree grows much like the Kieffer and is not as productive. Ripens earlier than that variety. Its color is a clearer yellow than the Keiffer. No improvement on that variety.

Groveland. A late variety of the Anjou type, resembling it in shape and size. Hangs on better than that variety. Quality very good. Ripens about two weeks after the Anjou. Moderately productive.

Lawrence. A very good early winter variety. Of medium size, roundish pyriform. Flavor sweet, aromatic, very good. Color yellow with numerous russet dots. Moderately thrifty grower and has a spreading habit. Very productive. Ripens October 15.

Morman Late. Of the Kieffer type but more distinctly pyriform. The color is a dull yellowish, with a waxy appearance and touch. Flavor much like that of the Kieffer. Stem very long. Promises to be quite productive. Not as handsome as Kieffer.

President. A large, smooth, roundish obovate pear of yellowish green color, well covered with a sprinkling of russet. Flavor mild and pleasant and the texture is a little coarse. The tree is vigorous and thrifty and quite productive. Ripens about October 20. A good variety for a fancy market.

All of the early pears bore well. The earliest, Wilder Early, bore a very good crop of handsomely colored fruit. It was of good size and free from blemishes. This variety, Giffard and Summer Doyenne all have a tendency to rot at the core. The next earliest, Summer Doyenne, is commonly called the "Little Sugar Pear" and is very common as an early sort. It is of good quality some seasons and in others is somewhat dry. It is valuable for a local market. Bloodgood was a little puckery this season. It ripens about the tenth of August, and is generally of good quality. The Seckel, Bosc and Danas Hovey, all of which are pears of high quality, bore very light crops. The Danas Hovey has been making very little growth during the last two years.

APPLES.

It was the same with apples as with pears this year. The size and quality of the crop depended upon the amount of spraying and the time at which it was done. If the early spraying was done at the proper time, the work of the fungus which attacks the blossom stem and causes the blossom to drop was prevented, while if done during the rainy weather, which was prevalent at the blossoming time, the spray was washed off before it had any effect to speak of.

The following newer varieties fruited this year:

Akin. A medium-sized fruit of a bright red color. Roundish oblate in form. A firm and handsome apple. The quality is good, the flavor being mild sub-acid, juicy and tender. The tree is productive and is a vigorous and thrifty grower somewhat spreading in habit. Needs plenty of sunlight to give a high color. A good variety for a fancy or dessert trade. Worthy of trial for that purpose. Season December to May. Its quality is best after Christmas.

Amerede Berthcourt. A variety received from the U. S. Division of Pomology in 1890 and was considered as a variety for cider making. The fruit is small, of a grayish green color with often a brick red tinge at the stem end. Form is roundish oblate slightly conical. Fruit is somewhat subject to scab. The flavor is somewhat peculiar, sub-acid and bitter. Texture is rather mealy, and lacks juice. The tree is rather a thrifty, upright grower. Not at all promising for any use, not even cider. We have too many cider apples of the standard varieties to consider setting varieties for that purpose. Ripens about October 3. Bore for the first time this year.

Atsion. A variety received from E. W. Reid, of Bridgeport, Ohio, Form roundish oblate, slightly conical. Color bright crimson over a greenish-yellow ground, sprinkled with scattering whitish spots. Russets somewhat, especially at the blossom end. Not an attractive apple. It has a short, slender stem. Flavor is very good, pleasant, sub-acid. Texture is firm with a crisp, juicy flesh. The appearance has so much to do with the value of an apple at the present time that this variety has not a very promising future. Ripens during the second week in October.

Babcock. Cions received from W. B. Babcock, Bridgman, Michigan, in 1904. Fruited for the first time this year. Its form is roundish oblong, slightly conical, smooth and regular. Color is a solid blush of glossy, dark red, on a greenish yellow ground, with numerous pinkish spots or dots. The fruit is very firm and has every appearance of being a good keeper. It is not at its best for eating until the latter part of December. The flavor is mild, sub-acid and pleasant. The stem is moderately long, slender and wiry. Has some promise as a long keeping apple.

Bath, Beauty of. The earliest ripening variety on trial, ripening about the last week of July. Of fine appearance, being a bright crimson red, beautifully spotted with large dots of greenish yellow. Form oblate conical. Flesh firm, fine-grained and moderately juicy. Flavor brisk, sub-acid of moderately good quality. Fairly productive. Should it prove more productive, it will be a valuable early variety.

Barbaric. Another cider apple variety received from the U. S. Department of Agriculture. Form regular, roundish oblate. The basin wide and deeply ribbed. Color dull yellowish green, splashed with dark red. Not attractive in appearance. Flavor somewhat puckery and not very pleasant. Ripens early in October. Texture firm. Not at all promising for any use.

Blanc Mollett. Also of the group of cider apples sent us by the U. S. Department of Agriculture in 1899. Form is a decided oblate conical, compressed. Color is reddish, verging to a reddish yellow on a yellow ground. Blushed and indistinctly striped. Flavor very poor, being bitter and puckery. Texture very firm. Flesh dry and tough. Small in size. Not promising.

Boiken. A bright, attractive yellow apple with a slight red blush. Form oblate, conical, often ribbed. Cavity is broad and deep. Stem moderately long and slender. Flavor is rather brisk sub-acid, too strong to make it a good dessert apple, altho sufficiently so for culinary purposes. A good keeper in storage. The tree is healthy and vigorous. Foliage large. Quite productive. Season November to March. Fruit quite resistant to scab.

Colfax. Fruit roundish oblate, very slightly conical. Flavor is mild sub-acid, very pleasant. Color is red, blushed and dashed on greenish-yellow ground. Firm and juicy. Flesh has a pinkish tinge in places at times. Ripens during the latter part of September. Size medium.

Dudley. A very good, medium early variety. Roundish, oblate conic fruit, of a rich creamy yellow color striped and splashed with a dark rich red. Flavor brisk sub-acid and of good quality. Of good size and appearance. Well shaped and not susceptible to scab. Tree not a very strong grower, but is vigorous. Of a spreading and drooping habit. Ripens during the first week in September. In the north it would make an early winter apple, and would be a very good variety for that part of the country.

Duchess Seedling. A fruit somewhat larger than the Duchess and ripening a few days earlier. The coloring is similar except that this variety has a cream-colored ground and is not so profusely striped as the Duchess. The growth of the tree is similar but the leaves are somewhat smaller. Does not come into bearing as early as does its parent and is not quite as prolific.

Fameuse Sucre. A sweet Snow apple. In appearance very similar to Fameuse or Snow, but generally colors up better and is even handsomer. Its pure white flesh in contrast with its dark, glossy red skin make a fine show. The quality is very good. In size about the same as Snow, ripens with it, and is about as productive. It makes an excellent dessert apple and should be tried by those desiring a fancy apple of the Fameuse type.

Fulton. Ripens the first week in November. It is handsome, distinctly oblate, very regular and smooth. Color, creamy, rich, blushed with an attractive red. Flavor, mild sub-acid and very pleasant, crisp, juicy and breaking. Flesh nearly white. Only fairly productive.

Hamilton (Black). A medium-sized yellow apple, ripening about the middle of September. The yellow is sometimes slightly overlaid with red. Quality very good, the flavor being brisk sub-acid. Flesh quite yellow, tender and crisp. Tree vigorous and quite productive. It shows bruises quite easily.

Milwaukee. Large, roundish oblate, and in color much like the Duchess, but is larger and later. Tree in habit similar to that variety. A good variety to extend the season of that type. Ripens September fifteenth.

Newby, (Doctor). Medium to large, oblate, angular variety of yellow color mostly covered with bright red. The basin is quite wide and shallow and is considerably wrinkled. The flavor is a pleasant sub-acid; texture firm. Season from December to March. The tree is moderately productive and comes into bearing quite early.

Newton Wonder. An irregular, oblate apple with a broad, flat basin and a small cavity. Being very flat at the stem end, the apple has a very flat appearance. Color a crimson red blush on a brownish yellow ground. In general it is an odd appearing apple. Flavor mild, sub-acid, very pleasant. Texture very firm and the flesh juicy and crisp. Appears to be a good keeper. Ripe early in October. Comes in bearing moderately early.

Star. Roundish oblate, somewhat lop-sided. Basin moderately deep, abrupt and wrinkled. Color yellowish green, with a brick-red cheek. Stem moderately thick and sometimes fleshy. Russets slightly from spraying. Flavor mild and pleasant. Good dessert quality. Flesh firm and juicy. Ripens during the last week in September.

Spencer. Roundish, irregular, conical. Handsome dark red, splashed and dashed on a handsome yellow ground. Flavor mild, sub-acid and very pleasant, making it a very good dessert apple. Flesh firm, crisp and juicy. Ripens about the twentieth of September. Thus far only moderately productive. Should it prove productive, it will be valuable as a fancy market apple. Must not be confounded with the Spencer Seedless Apple of recent notoriety.

Traveler. Received from Stark Brothers, and is supposed to come from New Zealand. Color greenish-yellow with a light brick-red cheek. Flavor sub-acid. Texture very firm and the variety has the appearance of being a very good keeper. From irregular, roundish oblate, often lop-sided. The basin is rather small and shallow and is generally russeted. Cavity quite narrow and deep. Stem short and slender. Flesh firm and crisp. Season November to April. Quite productive and starts bearing young. Tree not a large grower.

Wells. Sometimes called English Red Streak. A medium large, roundish oblate apple, striped and splashed with bright red on yellowish green ground. Flavor sub-acid and of fairly good quality. Texture firm, crisp and juicy. Fruit russets from spraying, especially at stem end, and has numerous russet spots. Ripens early in October.

Wall No. 1. Rather small, smooth, oblong conic. Color clear yellow with a bright red blush. Flavor mild sub-acid, somewhat watery. Basin deep and abrupt. Cavity small and narrow. Season December to March. Tree small, altho vigorous.

The following varieties have been well tested and are recommended for setting:

For market: Yellow Transparent, shows bruises, but brings high prices when carefully handled; Duchess; Chenango Strawberry; Strawberry Pippin, Sheepnose shape, very tender and needs thinning for good fruit, ripens unevenly, productive; Alexander and Wolf River are both of the same type, large handsome but of poor quality; Maiden Blush; McIntosh, a fancy variety; Wealthy, drops easily, comes into bearing early; Bailey Sweet, one of the best sweets; Wagener, prolific and comes into bearing early; R. I. Greening, very good cooking and eating apple but its color is against it for present day market; Baldwin, a profitable odd-year bearer in good locations; Northern Spy, grows well in Michigan, but has the fault of being a long time coming into bearing; King, trees short lived.

Varieties such as the Jonathan and Grimes Golden grow rather small in Michigan, but do well under favorable conditions. While Ben Davis is quite popular with some persons, it is grown so much better in other parts of the country that we cannot well compete on the market.

Winter Banana, one of the newer varieties, has proven very well here. It is sometimes a little ill-shaped and somewhat subject to the scab and Bordeaux injury, but it is a variety that we can grow well in this state.

For dessert and fancy market Primate (large, yellow, soft), Early Joe, Fanny, Garden Royal, Gravenstein, Golden Sweet, Chenango, Fameuse, Fameuse Sucre, McIntosh, Wagener, Jonathan, Spitzenberg, Red Canada, Winter Banana, Northern Spy, Roxbury Russet and Grimes Golden are recommended.

Primate, Garden Royal and Roxbury Russet are not very good looking apples but they have quality and are very good for home and dessert uses. In the above two lists the varieties are mentioned in the order of their season, the earliest coming first.

CULTURAL METHODS.

The test of the comparative values of cultivation and sod mulch was well under way this year. The test is being tried on peaches, plums (both European and Japanese), and apples. Each block is divided into four plots; viz. sod, mulched with straw or some non-manurial mulch; sod mulched with coarse manure; cultivation and cover crop, being cultivated until August first, after which the cover crop is sown; cultivation without a cover crop. The sod in the sod mulch plots is clover and the trees were thoroly mulched with the clover cut from between the trees and in addition in one case with coarse manure and in the other with straw. Enough was put on to mulch them to a radius of three feet from the trees. There seemed to be no decided difference in the plots this year. The drought had no more apparent effect on the mulched plots than it did on the cultivated. In fact, if there was any difference it was in favor of the mulched plots. The trees in this case made a more thrifty growth in the mulched plots than in the cultivated ones. All of the trees were set out in 1907 and were cultivated last year. It will take several years to get definite results.

TESTS OF SCALE REMEDIES.

In addition to a home-made lime-sulfur solution, the following remedies for San Jose scale were tested this year:

Rex Lime-sulfur Solution, manufactured by the Rex Company of Omaha, Nebraska, an amber fluid with some sediment in the bottom after standing. This is recommended to be mixed at the rate of one part of the solution to eleven of water for winter spraying.

Niagara Brand Lime-sulfur Solution, made by the Niagara Sprayer Company of Middleport, New York. This mixture has just been introduced here during the last year. In appearance it is very similar to the Rex brand and is mixed in the same proportion.

Cooper's Fluid VI (Winter Spray), made by William Cooper & Nephews of Berkhamsted, England, with American offices in Chicago, Illinois. A very smooth, fine oil, smelling quite strongly of carbolic acid. Mixed at the rate of one gallon to one hundred gallons of water.

Target Brand Scale Destroyer, made by the American Horticultural Distributing Company of Martinsburg, West Virginia. An oil spray of dark brown color, turning white when added to water. Mixed in proportions of one of oil to twenty-five of water.

Water Soluble Oil, made by the Thomson Chemical Company of Baltimore, Maryland. Also an oil mixture. Does not turn white when mixed with water. Mixed at the rate of one to twenty-five of water.

The tests were tried on moderately infested pear trees, and all of the mixtures were applied on April 20th.

The Rex and Niagara brands gave very similar results, both doing very efficient work, about equal to that obtained with the home-made lime-sulfur. These sprays do not whiten the trees as well as the 25-15-50 formula of the home-made mixture and it is well to add several pounds of lime, in the form of milk of lime to make the spray more noticeable, thus making it easier to tell how thoro the work has been done. The trees should always be gone over a second time to cover the places untouched by the first spraying.

The Target Brand Scale Destroyer and Cooper's Fluid VI. gave very poor results, neither seeming to have very much effect on the scale. The Target brand has been tried for several years here with the above result. Both mixtures stay in suspension very well. Cooper's Fluid costs $3.00 per gallon and one gallon is enough for one hundred gallons of spray. Regardless of efficiency, the cost would almost prohibit its general use. It costs about three times as much as the home-made lime-sulfur solution. The cost of the Target Brand Scale Emulsion is fifty cents per gallon and two gallons are needed for fifty gallons of spray. This makes its costs double that of the home-made sulfur-lime.

The Water Soluble Oil gave quite good results, altho not as good as that obtained with the lime-sulfur solutions. The scale increased on the trees sprayed with this mixture faster during the summer than it did on those sprayed with the lime-sulfur solutions. Its cost is the same as that of the Target Brand. Besides costing more and being less effectual for the scale, none of the oil sprays have the fungicidal value that the lime-sulfur sprays have.

Home-Made and Prepared Lime-Sulfur Mixtures:

The main difference for the consideration of the fruit grower in the use of a lime-sulfur spray between the home-made and the prepared mixtures is the cost. The present way of making the home-made lime-sulfur might also be a serious consideration when one thinks the trouble of making it is too great.

The prepared lime-sulfur mixtures cost the fruit growers between eleven and twelve dollars per barrel of fifty gallons. This is recommended for six hundred gallons of spray. The cost would be nearly one dollar per fifty gallons of spray.

In the usual way of making the home-made lime-sulfur with the 25-15-50 formula, the cost would be about fifty to seventy-five cents per fifty gallons of spray, including labor, fuel, etc., according to the cost of the sulfur.

One objection to the home-made mixture using the usual formula is that it has to be used soon after it is made and it should not be allowed to get cold. It is also considerable trouble, to say nothing of the unpleasant features of handling it, to prepare it, and especially if only a small amount is desired, many persons prefer to purchase the prepared mixtures, even tho they cost considerably more, and it will often be found more economical under such conditions, if one does not have at least a large kettle in which to prepare it.

CONCENTRATED HOME-MADE MIXTURES.

It is often convenient to prepare spraying mixtures well in advance of their application and it has been found that altho one made according to the usual formula which contains an excess of lime should not be allowed to get cold, by changing the formula so as to only have sufficient lime to unite with the sulfur, a mixture can be made which can be placed in barrels and thus kept for a considerable length of time.

By reducing the amount of lime to ten or twelve pounds for fifteen pounds of sulfur a clear mixture can be made and, in fact, it is only necessary to use eight pounds of lime for the above amount of sulfur.

The following procedure is suggested for use with a steam plant and it can be employed if only an iron kettle is available by reducing the amounts proportionately: Into a tank holding one hundred or more gallons, which contains fifty gallons of boiling water, place 125 pounds of sulfur and then add 70 pounds of stone lime. Turn on the steam and allow it to boil for one hour. In the meantime stir it once or twice if necessary. By this time the sulfur should be almost entirely dissolved. If time is no object, it will be helpful to continue the boiling for another hour. Allow it to stand until the coarse particles have settled and draw off the liquid portion, which can be bareled and kept until needed, when it can be diluted at the rate of one to nine of water, thus making 500 gallons. There will be more or less lime and sulfur in the bottom of the tank but this need not be turned out. Merely add more lime and sulfur in the above proportions and proceed as before. If the lime is of good quality, so that there is but little waste, it will be possible to reduce the amount for each tank full to sixty pounds. In case there is considerable waste lime, it can be placed upon a coarse screen and the fine particles of lime and sulfur can be washed out and the coarse lumps of lime can then be thrown away.

If prepared as recommended, the lime-sulfur solution will test about 25° with a Beaume hydrometer and when diluted one to nine will compare favorably with the average home-made sulfur-lime solution.

As is the case with the commercial mixtures, it has the drawback of not showing very plainly upon the trees, thus making it more difficult to secure an even application. To correct this it is only necessary to add a small amount of milk of lime, just before applying to the trees, until the desired color is secured.

In many places sulfur can be obtained at $2.00 per hundred pounds so that the expense for lime and sulfur to make 500 gallons of the diluted mixture need not be more than $3.00. After adding a liberal amount for labor, fuel and the use of the plant, it will be seen that the cost will be considerably less than one-half that of the commercial mixtures.

In sections where there are a large number of persons using lime-sulfur mixtures, it would seem an excellent business for someone to take up making the concentrated solution of sulfur-lime in a commercial way, as it can be sold, at a good profit at considerably less than the price charged for mixtures made in other states as there would be a large saving in the way of freight, commissions, advertising, etc.

TESTS OF SUMMER SPRAYS.

Tests of several materials as substitutes for the Bordeaux mixture were made this summer. The use of lime-sulfur which has been favorably tried in the west was one of the main ones. The manufacturers of prepared lime-sulfur recommended that their preparations be used in the proportions of one to twenty-five. We found, however, that that strength was too strong and had to reduce the mixtures to one to forty and even fifty. At one to twenty-five the Rex and Niagara brands were used on apples, pears, cherries and plums and in each case it burned the foliage. It was then too late to start anew on other trees and with poor weather conditions, the test was only fairly satisfactory.

Home-made lime-sulfur made by the 12-15-50 formula and reduced to one-fifth that strength for summer use did practically no harm to the foliage. As said before, when made by this formula, it can be prepared in condensed form and kept for use at any time, making it as handy for general use as the prepared lime-sulfur mixtures.

LIME-SULFUR AS A SUMMER SPRAY.

The results from the lime-sulfur tests showed that it had some value as a fungicide, altho the foliage on the trees sprayed with lime-sulfur did not appear as healthy or as large as that on the trees sprayed with Bordeaux. Part of this at least was due to the difference in the color of the two sprays. The yellow color of the lime-sulfur giving the trees a yellowish appearance, while the bluish color of the Bordeaux gives the leaves a deep green color. The prepared lime-sulfur seemed to give better results than the home-made.

The lime-sulfur was of little value as a remedy for the codling moth. Twenty per cent of the apples were wormy, while on trees sprayed with arsenate of lead only six per cent contained worms.

CALCIUM BENZOATE AS A SPRAY.

We also made a rather unsatisfactory test of a combination of Bordeaux mixture and Calcium Benzoate; the formula being in one case one pound of Calcium Benzoate, one pound copper sulfate, one pound lime and fifty gallons of water. The copper sulfate and lime were first made into Bordeaux and the benzoate added afterwards. This produces copper benzoate which is claimed to be good for controlling fungous diseases of all kinds. Another formula only contained one-half pound each of copper sulfate and lime to one pound of benzoate and fifty gallons of water. Our results this year did not indicate that this Benzoate-Bordeaux would control the scab and in a general way the results were inferior to those with regular Bordeaux mixture. Due to the poor weather, we were not able to spray both on the same day and the difference in the time of spraying might have made a difference in the results. To get definite results, we will have to try the Benzoate combinations under more favorable conditions.

Small lots of Grasselli's Bordeaux paste, a prepared Bordeaux, and of their Bordeaux Arsenate of Lead Paste were received. They mix with water about as well as arsenate of lead, but they do not stay in suspension nearly as well as a properly prepared home-made Bordeaux mixture, and we did not get as good results as with the home-made Bordeaux mixture and arsenate of lead, the arsenate of lead being used at the rate of two pounds to fifty gallons of the Bordeaux.

Cooper's fluid V 2, which is recommended as a summer spray for fruit trees is similar in appearance to the Fluid V 1, except that it is a lighter color. The results were quite unsatisfactory. The price of the material would alone keep the fluid from being generally used. The cost is the same as that of their winter spray, $1.50 for fifty gallons, while home-made Bordeaux mixture costs only thirty cents for the same quality.

Thus far we have not found a substitute for the three great remedies for the fruit tree pests: home-made Bordeaux mixture, home-made lime-sulfur mixture and arsenate of lead.

Frank A. Wilken.

South Haven, Mich., December 21, 1908.

FOREWORD.

The results of spraying experiments to control the black rot of the grape in Michigan are presented in this bulletin.

These experiments were made by Messrs. Shear and Hawkins of the Bureau of Plant Industry, U. S. Department of Agriculture, and the account of their work and results turned over to this Station for publication by Dr. B. T. Galloway, chief of the Bureau of Plant Industry.

It is hoped that the information here presented will be of value to the grape growers in sections where the black rot is a serious trouble.

R. S. SHAW,
Director.

GRAPE SPRAYING EXPERIMENTS IN MICHIGAN, 1907-8.

BY C. L. SHEAR AND LON A. HAWKINS.

Special Bulletin No. 49.

In 1906, so far as we could learn, but six sprayers were in use in the Lawton grape belt. Interest in spraying and confidence in its results have so increased that most of the growers have secured sprayers and are in most cases satisfactorily controlling the black rot. In the summer of 1908 at least 200 spraying outfits were found in use and perhaps there were others of which we did not learn. Thirteen different kinds were represented.

The work of 1907 was commenced in two vineyards in the vicinity of Paw Paw, but in one vineyard, that of Mr. J. M. Towers, it was discontinued on account of partial loss of the crop by frost and insects.

The work in the other vineyard, that of Mrs. Emma R. Smith, was continued throughout the season. This consisted of Concord vines about 25 years old, trained after the Kniffin system with the rows running north and south. The fruit the previous season had been almost totally destroyed by rot. Four plats adjoining each other were selected. The three sprayed plats contained about .46 of an acre each, and the check .115 of an acre.

The fungicides used were as follows: 5-5-50 Bordeaux; 4-4-50 Bordeaux; 3-3-50 Bordeaux. For the sixth and seventh applications, Burgundy mixture, composed of 1 lb. copper sulphate and 1½ lbs. sodium carbonate to 50 gallons of water, was used in order to avoid too much staining of the fruit. The work was done with a carbonic acid gas sprayer. (See Plate I, Fig. 1). The first applications were made with fixed nozzles and the last three with trailers, the nozzles being directed by hand. In order to determine the percentage of rot present on the different plats, counts of the sound and diseased grapes were made between September 23 and October 2; 1,000 bunches from each of the sprayed plats and 100 from the check being taken.

The following tables show the treatment of each plat:

PLAT NO. 1.

1907.	Fungicide used.	Stage of growth.
May 5	3 lbs. $CuSO^4$ to 50 gals. water	Dormant.
June 20	3–3–50 Bordeaux	Just beginning to blossom.
July 6	3–3–50 Bordeaux	Just after blossoming.
July 16	3–3–50 Bordeaux	Grapes about size of peas.
July 23	3–3–50 Bordeaux plus 2 lbs. soap	Grapes about one-third grown.
Aug. 2	Burgundy mixture (2)	Grapes about one-half grown.
Aug. 15	Burgundy mixture (2)	Grapes three-fourths grown.

PLAT NO. 2.

1907.	Fungicide used.	Stage of growth.
May 5	3 lbs. $CuSO^4$ to 50 gals. water	Dormant.
June 20	4–4–50 Bordeaux	Just beginning to blossom.
July 6	4–4–50 Bordeaux	Just after blossoming.
July 16	4–4–50 Bordeaux	Grapes about size of peas.
July 23	4–4–50 Bordeaux with 2 lbs. soap	Grapes about one-third grown.
Aug. 2	Burgundy mixture (2)	Grapes about one-half grown.
Aug. 15	Burgundy mixture (2)	Grapes three-fourths grown.

PLAT NO. 3.

1907.	Check.—Unsprayed except dormant application of copper sulphate solution.

PLAT NO. 4.

1907.	Fungicide used.	Stage of growth.
May 3	3 lbs. $CuSO^4$ to 50 gals. water	Dormant.
June 20	5–5–50 Bordeaux	Just beginning to blossom.
July 6	5–5–50 Bordeaux	Just after blossoming.
July 16	5–5–50 Bordeaux	Grapes about size of peas.
July 23	5–5–50 Bordeaux	Grapes about one-third grown.
Aug. 2	Burgundy mixture (2)	Grapes about one-half grown.
Aug. 15	Burgundy mixture (2)	Grapes about three-fourths grown.

The amount of rot on the plats at the close of the season was determined by actual count of the number of sound and affected berries on 1,000 average bunches from each plat, as stated above.

Just across a roadway at the south end of this vineyard was another which was very severely injured by black rot, in fact most of the crop was destroyed before the fruit was much over half grown. In order to get some idea of the effect of this apparently serious source of infection upon the portions of our plats closest to this vineyard, counts were made of the affected grapes at both ends of the rows, those adjoining the neglected vineyard and those fartherest from it.

The following table shows the percentage of rot at both ends of each plat and also the difference.

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*$CuSO^4$ is copper sulphate.

	Plat I.		Plat II.		Plat III.		Plat IV.	
	South end.	North end.	South end.	North end.	South end.	North end.	South end.	North end.
Bordeaux Mixture	3–3–50	3–3–50	4–4–50	4–4–50	Check	Check	5–5–50	5–5–50
Percentage of rot	56.4%	31.2	34.9	23.8	91.7	86.1	32.7	23.1
Greater percentage of rot on end adjoining unsprayed vineyard	25.2%		11.1%		5.6%		9.6%	

The average percentage of rot for the plat was as follows:

No. of plat.	No. of application.	Fungicide used.	Average % of rot.
I	7	3–3–50 Bordeaux	34.7
II	7	4–4–50 Bordeaux	28.7
III	None	Check unsprayed	89.2
IV	7	5–5–50 Bordeaux	28.3

Soap was used in 5th spraying in plats 1 and 2 and Burgundy mixture (2) for the 6th and 7th sprayings.

Although only 89.2 per cent of the fruit on the unsprayed plat was found by actual count to be destroyed, yet it was not considered practicable to try to harvest any of it because the expense of separating the small quantity of sound fruit would have been much more than its value. The crop of the unsprayed plat was, therefore, practically a total loss. It will be noted that there was scarcely any difference in the amount of rot on the plat sprayed with 4-4-50 and that sprayed with 5-5-50 Bordeaux mixture. Part of a vine from the latter plat is shown in Plate II, Fig. 1 and a typical vine from a neighboring and neglected vineyard showing not only complete destruction of the fruit, but also defoliation which prevented the proper maturing of the season's growth of shoots.—Plate II, Fig. 2.

The following itemized account shows the gain due to spraying on plat II and the corresponding gain per acre estimated, upon the same basis:

FIVE APPLICATIONS WITH 4–4–50 BORDEAUX AND 2 OF BURGUNDY, OR 475 GALLONS IN ALL ON .46 ACRE.

COST OF LABOR:	
Man and team to spray, 8¾ hrs. at 35 cents per hour	$3 06
Man and horse to haul Bordeaux mixture, 8¾ hrs at 35 cents per hour	2 18
Two men to carry trailers for last 3 sprayings, 5¼ hrs. at 15 cents per hr. each	1 68
COST OF MATERIALS:	
Two-thirds tube gas at $2.35 per tube	1 55
Copper Sulphate, 26 lbs. at 8¾ cents	2 28
Resin fish-oil soap, 11 lbs. at 3½ cents	39
Sal Soda, 6 lbs. at 3 cents	18
Total cost for .46 acre	$11 32
RETURNS:	
Two thousand ten lbs. of grapes harvested on sprayed plat sold at $40 per ton (As no fruit was harvested on the unsprayed plat, this amount is all attributed to spraying.)	$40 20
Cost of spraying	11 32
Gain on .46 acre	$28 88
Gain per acre at same rate	62 30

The work in 1908 was carried on in three different vineyards; Mrs. Emma Smith's as already described; Mr. J. M. Towers' near Paw Paw;

and Mr. C. C. Giddings' vineyard near Lawton. The work in Mrs. Smith's vineyard was conducted on the same plats used in 1907 and with the same spraying outfit, and as before trailers with nozzles directed by hand were use instead of fixed nozzles for the last three sprayings. It was found that in order to satisfactorily cover the foliage and fruit, at the time of the later spraying the nozzles, or part of them at least, must be thus manipulated.

The treatment given Mrs. Smith's vineyard, is shown in the following tables:

PLAT NO. 1.

1908.	Fungicide used.	Stage of growth.
May 19	4–4–50 Bordeaux	Shoots about 6 inches long.
May 29	4–4–50 Bordeaux	Shoots 18-24 inches long.
June 2	4–4–50 Bordeaux	Shoots 20-28 inches long.
June 15	4–4–50 Bordeaux	Just after blooming.
June 24	4–4–50 Bordeaux	Grapes about the size of peas.
July 3	4–4–50 Bordeaux	Grapes about half grown.
July 22	4–2–50 Bordeaux	Grapes four-fifths grown.

PLAT NO. 2.

1908.	Check unsprayed.

PLAT NO. 3.

1908.	Fungicide used.	State of growth.
May 19	4–3–50 Bordeaux	Shoots about 6 inches long.
May 29	4–3–50 Bordeaux	Shoots 18-24 inches long.
June 2	4–3–50 Bordeaux	Shoots 20-28 inches long.
June 15	4–3–50 Bordeaux	Just after blooming.
June 24	4–3–50 Bordeaux	Grapes about the size of peas.
July 3	4–3–50 Bordeaux	Grapes about one-half grown.
July 6	4–3–50 Bordeaux	Grapes about one-half grown.
July 22	4–2–50 Bordeaux	Grapes about four-fifths grown.

PLAT NO. 4.

1908.	Fungicide used.	Stage of growth.
May 19	4–2–50 Bordeaux	Shoots about 6 inches long.
May 29	4–2–50 Bordeaux	Shoots 18-24 inches long.
June 2	4–2–50 Bordeaux	Shoots 20-28 inches long.
June 15	4–2–50 Bordeaux	Just after blooming.
June 24	4–2–50 Bordeaux	Grapes about the size of peas.
July 6	4–2–50 Bordeaux	Grapes one-half grown.
July 22	4–2–50 Bordeaux	Grapes about four-fifths grown.

The following table shows the percentage of rot as determined by actual count, as in the preceding season's work:

No. of plat.	No. of application.	Fungicide used.	Per cent of rot by count.
I	7	4–4–50 Bordeaux	0.197
II	None	Check unsprayed (but sprayed in 1907)	17.257
III	8	4–3–50 Bordeaux	.034
IV	7	4–2–50 Bordeaux	.178

The small amount of rot on the check plat was, we believe, largely due to the fact that this plat was sprayed in the season of 1907. It would have been better, perhaps, for purposes of comparison, to have used the same check as in 1907. As the amount of rot on a neglected vineyard near by was as great in 1908 as the previous year, there seems to be no reason to suppose that the rot on this unsprayed plat would not have been about as great also, except for the treatment given it in 1907.

It will be noted that in this experiment the plats sprayed with 4-3-50 Bordeaux mixture showed the least amount of rot. The very small precentage of rot on all the plats illustrated very clearly what may perhaps be called the cumulative effect of spraying. The disease having been largely brought under control the first season, can generally be much more easily handled succeeding seasons.

The following is an itemized account of the work showing the gain on plat 3.

SEVEN SPRAYINGS WITH 4–3–50 BORDEAUX AND ONE WITH 4–2–50, 500 GALLONS IN ALL ON .46 ACRE.

COST OF LABOR:		
Man and team to spray 10 hrs. at 35 cents per hour		$3 50
Man and horse to haul Bordeaux mixture 10 hours at 25 cents per hour		2 50
Two men to carry trailers in last 4 sprayings, 6 hours at 15 cents per hour each		1 80
COST OF MATERIALS:		
Copper Sulphate, 40 lbs. at 6¾ cents		2 70
Stone lime, 30 lbs. at two-thirds cents		20
Five sevenths tube of gas at $2.35 per 50 lbs. tube		1 67
Total cost per .46 acre		$12 37
Cost of spraying one acre		26 90
RETURNS:		
Yield on sprayed plat 660 8-lb. baskets at $0.1166 per basket	$76 95	
Receipts per acre at same rate		$167 29
Yield on check plat 1,134.75 lbs. at $20.64 per ton	$11 71	
Returns per acre at same rate		101 71
Gain per acre from spraying		$65 58
Cost per acre for spraying		26 90
Net gain per acre		$38 68

Grapes in same vineyard sprayed 5 times showed no appreciable difference in amount of rot. Difference in net gain this year was due to extra sprayings, and less loss on check as result of previous treatment (1907).

In 1908 spraying experiments were again started in Mr. J. M. Tower's vineyard, near Paw Paw. This vineyard consisted of Concord vines about 8 years old, with the rows running north and south. Nine plats, .488 of an acre each as nearly uniform in character and condition as possible, were selected. The work was done with the geared traction sprayer shown in Plate II, Fig. 2. The mixing platform is also shown in the same figure.

The following mixtures were used: Bordeaux 4-4-50, 4-3-50, 4-2-50, 5-5-50, 5-4-50 and 5-3-50, also Sodium Benzoate Bordeaux (1) and (2). Six applications were made as shown in the accompanying tables, the last one consisting of 4-2-50 Bordeaux.

PLAT I.

1908.	Fungicide used.	Stage of growth.
May 20	4–4–50 Bordeaux	Shoots about 8 inches long.
May 30	4–4–50 Bordeaux	Shoots 16-20 inches long.
June 17	4–4–50 Bordeaux	Just after blossoming.
June 29	4–4–50 Bordeaux	Grapes the size of peas.
July 13	4–4–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT II.

1908.	Fungicide used.	Stage of growth.
May 20	4–3–50 Bordeaux	Shoots about 8 inches long.
May 30	4–3–50 Bordeaux	Shoots 16-20 inches long.
June 17	4–3–50 Bordeaux	Just after blossoming.
June 29	4–3–50 Bordeaux	Grapes the size of peas.
July 13	4–3–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT III.

1908.	Fungicide used.	Stage of growth.
May 20	4–2–50 Bordeaux	Shoots about 8 inches long.
May 30	4–2–50 Bordeaux	Shoots 16–20 inches long.
June 17	4–2–50 Bordeaux	Just after blossoming.
June 30	4–2–50 Bordeaux	Grapes the size of peas.
July 13	4–2–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT IV.

1908.	Check, unsprayed.

PLAT V.

1908.	Fungicide used.	Stage of growth.
May 20	5–5–50 Bordeaux	Shoots about 8 inches long.
May 30	5–5–50 Bordeaux	Shoots 16–20 inches long.
June 17	5–5–50 Bordeaux	Just after blossoming.
June 30	5–5–50 Bordeaux	Grapes the size of peas.
July 13	5–5–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT VI.

1908.	Fungicide used.	Stage of growth.
May 20	5–4–50 Bordeaux	Shoots about 8 inches long.
May 30	5–4–50 Bordeaux	Shoots 16-20 inches long.
June 17	5–4–50 Bordeaux	Just after blossoming.
June 30	5–4–50 Bordeaux	Grapes the size of peas.
July 13	5–4–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT VII.

1908.	Fungicide used.	Stage of growth.
May 20	5–3–50 Bordeaux	Shoots about 8 inches long.
June 1	5–3–50 Bordeaux	Shoots about 16-20 inches long.
June 17	5–3–50 Bordeaux	Just after blossoming.
June 30	5–3–50 Bordeaux	Grapes the size of peas.
July 13	5–3–50 Bordeaux	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT VIII.

1908.	Fungicide used.	Stage of growth.
	Sodium Benzoate Bordeaux Formula (2)	
May 20	1–1–½–50	Shoots about 8 inches long.
June 1	1–1–½–50	Shoots 18-20 inches long.
June 18	1–1–½–50	Just after blossoming.
June 30	1–1–½–50	Grapes the size of peas.
July 14	1–1–½–50	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT IX.

1908.	Fungicide used.	Stage of growth.
	Sodium Benzoate Bordeaux Formula (1)	
May 20	2–1–1–50	Shoots about 8 inches long.
June 1	2–1–1–50	Shoots 16-20 inches long.
June 18	2–1–1–50	Just after blossoming.
June 30	2–1–1–50	Grapes the size of peas.
July 14	2–1–1–50	Grapes about three-fourths grown.
July 25	4–2–50 Bordeaux	Grapes nearly full grown.

The results are shown in the following table:

No. of plat.	No. of application.	Fungicides used.	Percentage of rot by count.
I	6	4–4–50 Bordeaux 1st 5 applications	0.03
II	6	4–3–50 Bordeaux 1st 5 applications	0.097
III	6	4–2–50 Bordeaux	0.042
IV	None	Check, unsprayed	7.36
V	6	5–5–50 Bordeaux 1st 5 applications	0.051
VI	6	5–4–50 Bordeaux 1st 5 applications	0.07
VII	6	5–3–50 Bordeaux 1st 5 applications	0.064
VIII	6	Sodium Benzoate Bordeaux 1–1–½–50 formula (2)	0.083
IX	6	Sodium Benzoate Bordeaux 2–1–1–50 formula (1)	0.127

4–2–50 Bordeaux was used in 6th spraying on all plats.

The percentages of rot given were obtained by actual count of the rotten grapes on clusters showing average condition of each plat as in the other cases. It will be noted that the smallest percentage of rot was found on Plat I treated with 4-4-50 Bordeaux mixture. The difference in amount of rot, however, on the various plats was so slight in most cases as to give no very decided indication as to the comparative value of the different mixtures. The amount of rot on the check plat was also small.

MR. GIDDING'S VINEYARD.

This vineyard consisted of Concord vines about 14 years old. Eleven plats of one-third acre each were used in the experiments. The work was done with a geared traction sprayer, using fixed nozzles for the first three applications, and trailers with the nozzles directed by hand, for the last three applications.

The following tables show the treatment given each plat:

PLAT I.

1908.	Fungicide used.	Stage of growth.
May 21	4–4–50 Bordeaux	Shoots about 8 inches long.
June 2	4–4–50 Bordeaux	Shoots about 18-24 inches long.
June 15	4–4–50 Bordeaux	Just after blossoming.
June 25	4–4–50 Bordeaux	Grapes the size of peas.
July 8	4–4–50 Bordeaux	Grapes about one-half grown.
July 23	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT II.

1908.	Fungicide used.	Stage of growth.
May 21	4–3–50 Bordeaux	Shoots about 8 inches long.
June 2	4–3–50 Bordeaux	Shoots 18-24 inches long.
June 15	4–3–50 Bordeaux	Just after blossoming.
June 25	4–3–50 Bordeaux	Grapes the size of peas.
July 8	4–3–50 Bordeaux	Grapes about one-half grown.
July 23	4–2–50 Bordeaux	Grapes nearly full grown

PLAT III.

1908.	Fungicide used.	Stage of growth.
May 21	4–2–50 Bordeaux	Shoots about 8 inches long.
June 2	4–2–50 Bordeaux	Shoots 18-24 inches long.
June 15	4–2–50 Bordeaux	Just after blossoming.
June 25	4–2–50 Bordeaux	Grapes the size of peas.
July 8	4–2–50 Bordeaux	Grapes about one-half grown.
July 23	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT IV.

1908.	Fungicide used.	Stage of growth.
May 21	3–2–50 Bordeaux	Shoots about 8 inches long.
June 2	3–2–50 Bordeaux	Shoots 18-24 inches long.
June 15	3–2–50 Bordeaux	Just after blossoming.
June 25	3–2–50 Bordeaux	Grapes the size of peas.
July 8	3–2–50 Bordeaux	Grapes about one-half grown.
July 23	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT V.

1908.	Check, unsprayed.

PLAT VI.

1908.	Fungicide used.	Stage of growth.
May 21	4–2–50 Bordeaux with 2 lbs. soap	Shoots about 8 inches long.
June 2	4–2–50 Bordeaux with 2 lbs. soap	Shoots 18-24 inches long.
June 15	4–2–50 Bordeaux with 2 lbs. soap	Just after blossoming.
June 25	4–2–50 Bordeaux with 2 lbs. soap	Grapes the size of peas.
July 8	4–2–50 Bordeaux with 2 lbs. soap	Grapes about one-half grown.
July 23	4–2–50 Bordeaux	Grapes nearly full grown.

PLAT VII.

1908.	Fungicide used.	Stage of growth.
May 21	3–2–50 Bordeaux with 2 lbs. soap.................	Shoots about 8 inches long.
June 2	3–2–50 Bordeaux with 2 lbs. soap.................	Shoots 18-24 inches long.
June 15	3–2–50 Bordeaux with 2 lbs. soap.................	Just after blossoming.
June 25	3–2–50 Bordeaux with 2 lbs. soap.................	Grapes the size of peas.
July 8	3–2–50 Bordeaux.................................	Grapes about one-half grown.
July 23	4–2–40 Bordeaux.................................	Grapes nearly full grown.

PLAT VIII.

1908.	Fungicide used.	Stage of growth.
May 21	Copper Borate Mixture (2).........................	Shoots about 8 inches long.
June 2	Copper Borate Mixture (2).........................	Shoots 18-24 inches long.
June 15	Copper Borate Mixture (2).........................	Just after blossoming.
June 25	Copper Borate Mixture (2).........................	Grapes the size of peas.
July 8	Copper Borate Mixture (2).........................	Grapes about one-half grown.
July 23	4–2–50 Bordeaux.................................	Grapes nearly full grown.

PLAT IX.

1908.	Fungicide used.	Stage of growth.
May 21	Neutral Copper Acetate............................	Shoots about 8 inches long.
June 2	Neutral Copper Acetate............................	Shoots 18-24 inches long.
June 15	Neutral Copper Acetate............................	Just after blossoming.
June 25	Neutral Copper Acetate............................	Grapes the size of peas.
July 8	Neutral Copper Acetate............................	Grapes about one-half grown.
July 23	4–2–50 Bordeaux.................................	Grapes nearly full grown.

PLAT X.

1908.	Fungicide used.	Stage of growth.
May 21	Self-boiled Lime-sulphur (2)......................	Shoots about 8 inches long.
June 2	Self-boiled Lime-sulphur (2)......................	Shoots 18-24 inches long.
June 16	Self-boiled Lime-sulphur (2)......................	Just after blossoming.
June 26	Self-boiled Lime-sulphur (2)......................	Grapes the size of peas.
July 8	Self-boiled Lime-sulphur (2)......................	Grapes about one-half grown.
July 23	4–2–50 Bordeaux.................................	Grapes nearly full grown.

PLAT XI.

1908.	Fungicide used.	Stage of growth.
May 21	Com. Lime-sulphur 1–50...........................	Shoots about 8 inches long.
June 2	Com. Lime-sulphur 1–50...........................	Shoots 18-24 inches long.
June 16	Com. Lime-sulphur 1–50...........................	Just after blossoming.
June 26	Com. Lime-sulphur 1–50...........................	Grapes the size of peas.
July 9	Com. Lime-sulphur 1–50...........................	Grapes about one-half grown.
July 23	4–2–50 Bordeaux.................................	Grapes nearly full grown.

As the grape berry-moth was causing considerable loss in the vineyard an arsenical preparation, made in accordance with directions of Prof. A. L. Quaintance of the Bureau of Entomology, was added to the Bordeaux mixture for the second, third and fourth applications on all the plats.

The following table shows the results of the treatment of each plat:

No. of plat.	No. of application.	Fungicide used.	Per cent of rot by count.	Yield 8-lb. baskets.
I	6	4–4–50 Bordeaux	0.051	187
II	6	4–3–50 Bordeaux	0.043	166
III	6	4–2–50 Bordeaux	0.15	148
IV	6	3–2–50 Bordeaux	0.17	120
V	None	Check unsprayed	28.317	78
VI	6	4–2–50 Bordeaux with 2 lbs. soap	0.411	137
VII	6	3–2–50 Bordeaux with 2 lbs. soap	0.531	140
VIII	6	Copper Borate Mixture (2) with 1 lb. soap	2.464	125
IX	6	Neutral Copper Acetate 1–50	1.088	134
X	6	Self-Boiled Lime and Sulphur (2)	2.413	120
XI	6	Com. Brand Lime and Sulphur 1–50	3.383	Record wanting

4–2–50 Bordeaux was used for the 6th application on all the plats.

The percentages of rot were determined by actual count of the diseased berries on 1,000 average bunches as in the previous cases. The yield in 8-pound baskets is also given for each plat except the last, the record of which is missing. The smallest percentage of rot, as indicated above, was found on Plat II treated with 4-3-50 Bordeaux mixture. The difference between this plat and Plat I, treated with 4-4-50 Bordeaux mixture, is, however, very light. A portion of a vine from Plat II, showing the condition of the fruit, is shown in Plate III, Fig. 1, and a portion of a vine from the unsprayed checks, showing the general appearance of the fruit, is shown in Plate III, Fig. 2. The lime sulphur mixtures produced decidedly less satisfactory results than the Bordeaux. The self-boiled lime-sulphur, which was prepared with hot water, injured the foliage somewhat and the commercial concentrated solution, at the rate of 1 gallon to 50 gallons of water, burned the foliage still more seriously and therefore is unsafe to use in this strength. The results of the treatment with lime-sulphur were so much less satisfactory in this case than in New York experiments in 1908, in which the first application was made with Bordeaux mixture, that it throws considerable doubt upon the part played by lime-sulphur in controlling the rot in that case. Further experiments are needed to determine whether lime-sulphur solutions in any form or strength, in which they can be used, will prove a desirable substitute for Bordeaux mixture. The neutral copper acetate solution, 1 lb. to 50 gallons of water, gave better results than any other of the applications except Bordeaux mixture.

The following account shows the expense of spraying and the gain from Plat II, one-third of an acre, sprayed six times with 4-3-50 Bordeaux, and the estimated gain per acre at the same rate:

TWO HUNDRED FIFTY-EIGHT GALLONS APPLIED.

EXPENSES:	
Labor, man and team, 2 hours at 35 cents	$0 70
Labor, 2 men to carry trailers in last 3 sprayings, 1 hour 15 cents each	30
Copper Sulphate, 20⅔ lbs. at 6 cents	1 24
Stone Lime, 15⅓ lbs. at ⅔ cents	10
Expense of spraying one-third acre	$2 34
RETURNS:	
Yield from sprayed plat, 166 8-lb. baskets at 12½ cents each	$20 75
Yield from check plat, 119 8-lb. baskets at 12½ cents	14 87½
Gain by spraying	$5 87½
Cost of spraying	2 34
Net gain on one-third acre	$3 53½
Net gain per acre at same rate	10 60½

There was an additional loss on check of 15.6 per cent due to the berry-moth, making a total loss of 43.9 per cent. As this loss was almost entirely prevented on the sprayed plats without additional cost, except for the poison used, the above statement does not show all the profit due to spraying.

MIXTURE USED.

Burgundy Mixture—Two formulae were used. (1) Composed of 1½ lbs. of copper sulphate and 2 lbs. of sodium carbonate to 50 gals. water; (2) composed of 1 lb. copper sulphate and 1½ lbs. sodium carbonate to 50 gals. water.

Sodium Benzoate Bordeaux Mixtures were prepared as follows: (1) 2 lbs. copper sulphate, 1 lb. lime, 1 lb. sodium benzoate to 50 gals. water; (2) 1 lb. copper sulphate, 1 lb. lime, ½ lb. sodium benzoate to 50 gals. water. The ingredients were dissolved separately and mixed in a dilute condition.

Copper Borate Mixture—Mixtures of this fungicide were prepared according to the following formulae: (1) 1½ lbs. copper sulphate, 2 lbs. borax, 50 gals. water; (2) 1¼ lbs. copper sulphate, 2 lbs. borax, 50 gals. water; (3) 1 lb. copper sulphate, 2 lbs. borax to 50 gals. water. Resin fish-oil soap was also added to most of these mixtures to improve their adhesive qualities and to determine the benefit to be derived from this source.

Neutral Copper Acetate Solution—1 lb. neutral copper acetate dissolved in 50 gals. water.

Self-Boiled Lime Sulphur—Eight lbs. of flowers of sulphur mixed with 15 lbs. of stone lime, with the addition of hot water, diluting the whole to 50 gals., also 10 lbs. sulphur to 15 lbs. of lime with the same quantity of water.

Commercial Lime-Sulphur—One gal. of the concentrated solution added to 50 gals. of water.

GENERAL RECOMMENDATIONS.

The following sprayings are suggested for Michigan vineyards:

First time. When the shoots are about 10 inches long, Bordeaux 4-3-50.

Second time. Just before blooming, Bordeaux as before with the addition of an arsenical poison* for grape berry moth.

Third time. Just as the blossoms fall with Bordeaux and poison as before.

Fourth time. About ten days or two weeks after the previous application with Bordeaux and the poison.

This fourth application and further ones depend upon weather conditions and the amount of rot prevalent in the vineyard. If another spraying is deemed necessary, use Bordeaux only; and if more are given, use the neutral copper acetate 1 lb. to 50 gal. of water to prevent staining the fruit.

Do all the spraying very thoroughly. Fixed nozzles can be used in all but the last two or three applications when trailers with nozzles directed by hand should be used.

Old rotten grapes or prunings left in the vineyard or about the packing shed are a source of infection. It pays to gather and burn or bury these "mummies" and prunings.

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*The cheapest poison is made with 4 lbs. washing soda, 1 lb. white arsenic, 1 gal. water. Mix the washing soda and the arsenic, add the water and boil until dissolved. Keep in jugs or jars and mark "Poison" very plainly. Use 1 pint of this solution to 50 gallons of Bordeaux. If arsenate of lead is preferred, use 2 lbs. to 50 gals. of Bordeaux.

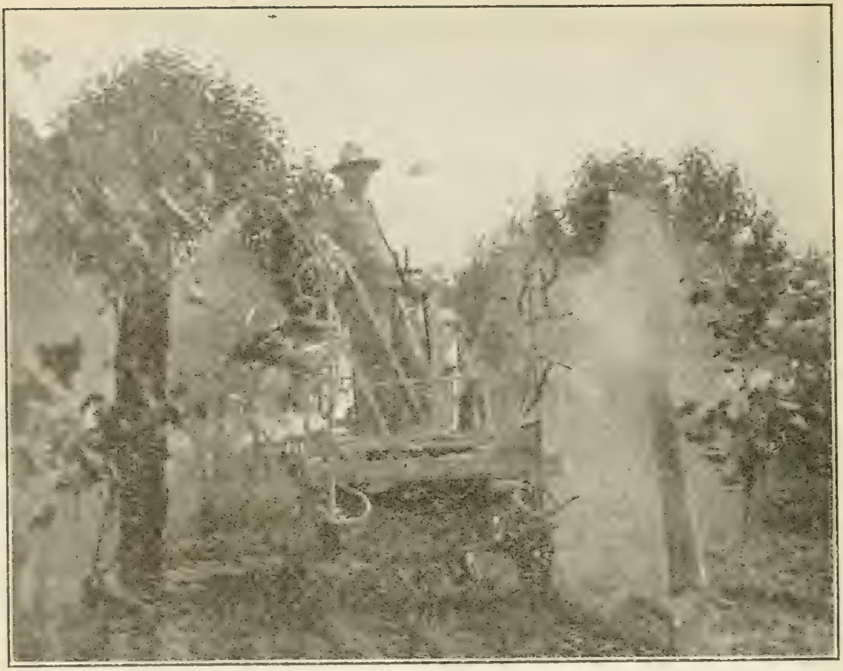

Fig. 1.—Carbonic acid gas sprayer used in spraying experiments in 1907 and 1908 in Mrs. Smith's vineyard, Paw Paw, Michigan.—Photo by Lon A. Hawkins.

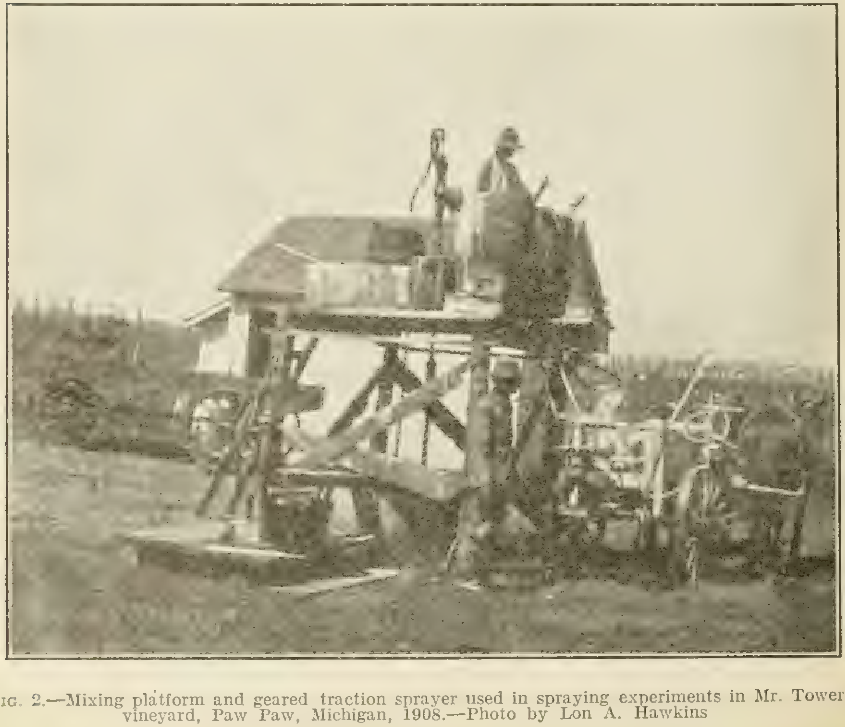

Fig. 2.—Mixing platform and geared traction sprayer used in spraying experiments in Mr. Towers vineyard, Paw Paw, Michigan, 1908.—Photo by Lon A. Hawkins

PLATE I.

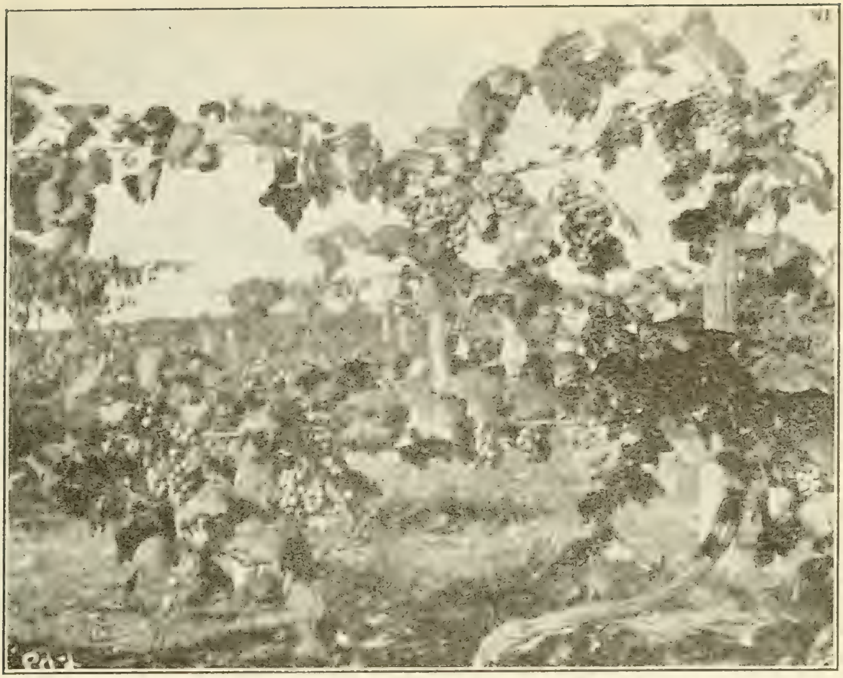

Fig. 1.—Part of a Concord vine sprayed with 5-5-50 Bordeaux Mixture, Mrs. Smith's vineyard, Paw Paw, Michigan.—Photographed Sept. 8, 1907 by Lon A. Hawkins.

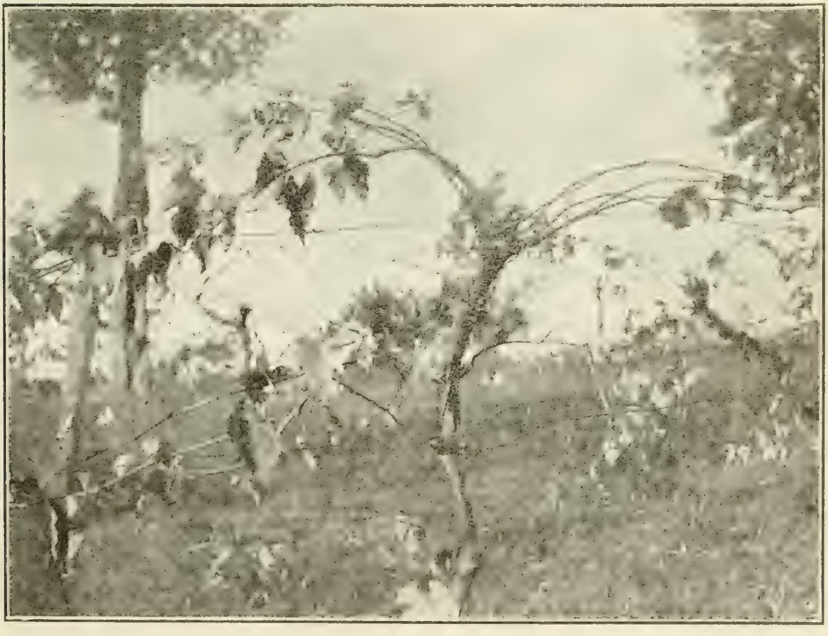

Fig. 2.—Vine from unsprayed and neglected vineyard in the same neighborhood. Photographed the same day as Fig. 1. Crop entirely destroyed by blackrot and the vines defoliated.—Photo by Lon A. Hawkins.

PLATE II.

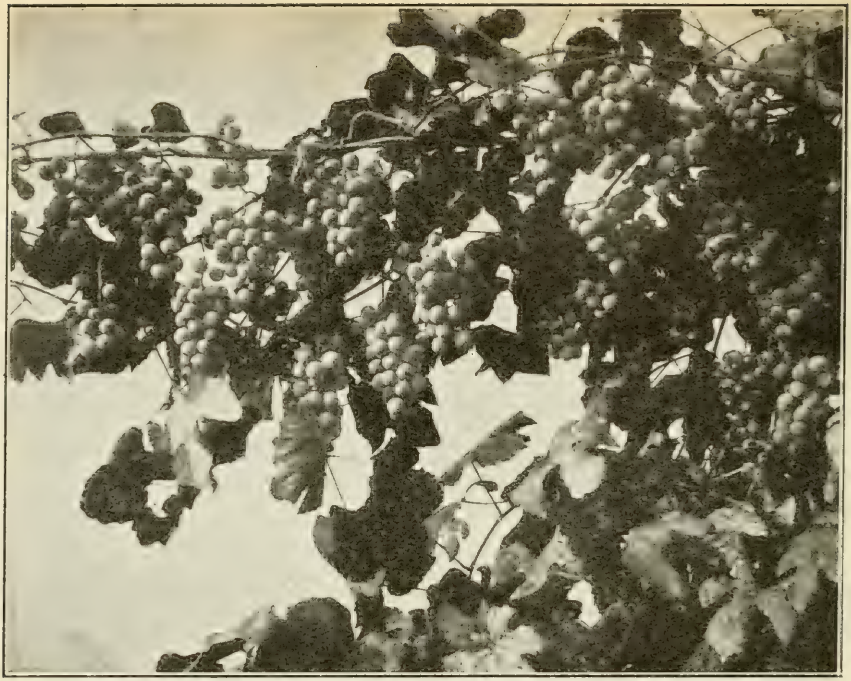

Fig. 1.—Grapes on plat sprayed with 4–3–50 Bordeaux Mixture, Mr. Giddings' vineyard, Lawton, Michigan. Photographed Sept. 12, 1908. Less than 5-100 of 1% loss from blackrot.—Photo by Lon A. Hawkins

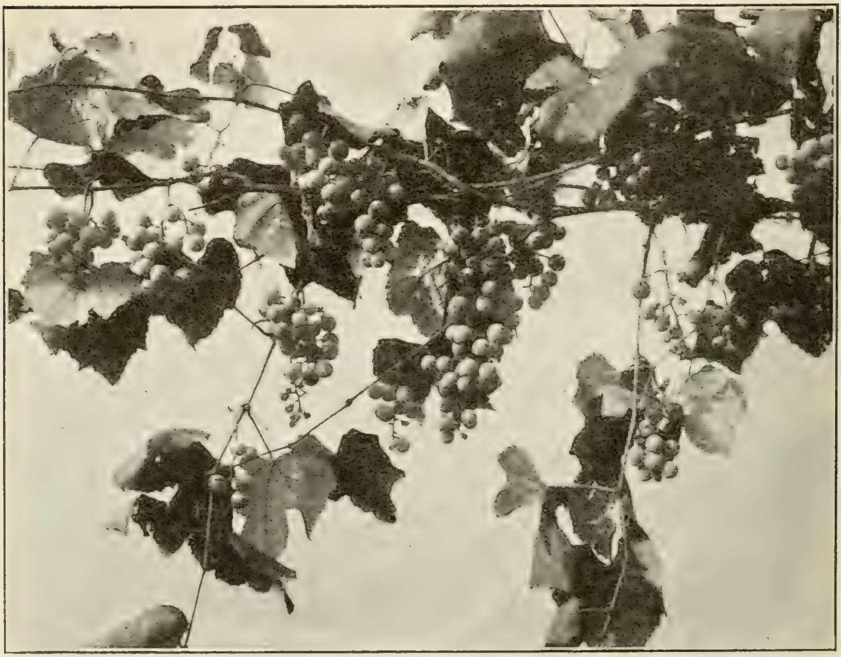

Fig. 2.—Grapes on unsprayed check plat, Mr. Giddings' vineyard, Lawton, Michigan. Photographed Sept. 12, 1908. 28.3 per cent of the fruit destroyed by blackrot.—Photo by Lon A. Hawkins.

PLATE III.

ALFALFA

NOTES RELATING TO SUITABILITY OF SOILS, CULTIVATION, SEEDING, FERTILIZING, ETC.

Circular No. 1.

Greatly varied results have been secured from alfalfa growing in Michigan; a great variety of methods have been employed on nearly every kind of soil under widely varying conditions; no uniform rules seem to have been observed in this work. It is much better to employ every possible means to secure a stand on a small area each year and succeed, than to attempt to seed a large acreage in an unsuitable or haphazard way and fail.

Selection of Suitable Land.—In selecting a suitable site for alfalfa growing avoid the low lying, wet, cold lands with water level nearer than five or six feet of the surface. Also avoid high, wet lands, such as seepy hillsides. It is desirable, as far as practicable, to grow alfalfa on lands not suited to cereal crop production, such as the lighter, sandy and gravelly areas and high, barren hills and ridges; for there is a possibility of utilizing these lands in this way while other crops may not be profitable. Alfalfa should be regarded as a permanent crop too valuable to use in a short rotation to be plowed under after two or three years, in the same manner as clover. Where clover succeeds well and the crop rotation is a short one it should be used.

Suitability of Soils.—

An exact statement as to the most suitable soils cannot be made because of the influences of local conditions. Two soils of the same general character, but in different localities, may produce far from the same results.

The sub-soil should be sufficiently permeable and porous to permit proper aeration, drainage and penetration of roots. An impenetrable hard-pan sub-soil is extremely undesirable.

In general the most suitable alfalfa soils are those of the *deep, rich, loamy, or sandy loam types. Muck soils* do not seem to be satisfactory. The results from *clay* soils seem to be variable. If *clays* overlay a somewhat porous sub-soil the alfalfa seems to thrive, but if the sub-soil is impervious to the percolation of water, interfering with natural drainage, thus producing cold, wet conditions, the results are bad. With this class of soils the plants are more subject to heaving in the winter and spring.

Sandy and Gravelly Soils.—

In general, alfalfa can be grown quite successfully on this class of soils even though lacking in humus and certain elements of plant food. The chief difficulty in connection with these soils is to get the alfalfa plants well started, but when once established under these conditions, the crop will do better than any cereal or grass crop that could be used.

Cultivation.—

In all cases the land should be continuously and thoroughly cultivated to free it from all vegetable growth before seeding. Weeds are about the most troublesome factor in securing a stand unless entirely destroyed before the alfalfa is planted. Soils of the clay and loam class should be plowed and cultivated deep and thoroughly. The light, sandy or gravelly soils should not be plowed, cultivated or loosened up deep shortly before the seeding time; for these soils it is desirable to secure a compact, firm seed bed.

Manuring.—

No manuring may be necessary in the case of the deep, rich, well tilled loam, but a light top dressing of fine well rotted manure goes far to insure a stand of alfalfa on clays, sands and gravel soils. It is desirable on the clay, not so much to furnish plant food as to prevent the ground from drying out, baking and cracking. On the sand and gravel, the top dressing is needed to prevent the sand from drifting, to furnish food for the young plant, to shade the ground and conserve moisture, and, on steep hillsides, to aid in checking washing. Farmyard manure plowed under deep, while very valuable later, does not furnish aid at the time or in the manner heretofore suggested. The top dressing is particularly essential in seeding barren hill tops, washy slopes and light sands. The manure should be applied after plowing so that the subsequent cultivation, necessary to produce a suitable seed bed, will intermix it with one or two inches of the surface soil, rather than leave it entirely on the surface except in the case of a blow sand. The manure should be fine and well rotted so as not to interfere with cultivation or spread weed seeds; the amount needed will vary from six to twelve loads per acre, depending on soil, season, climatic and various other conditions. The manure can be applied and distributed most perfectly by means of the spreader.

Time of Seeding.—

This will vary with the locality and the season, but may begin as soon as danger of severe frost is past, say about May 1st, and may continue as late as there is prospect of getting a vigorous growth to withstand winter; this will also depend on the season and the use of a top dressing of manure. Last season we seeded successfully up to August 1st.

Amount of Seed.—

From 15 to 20 pounds of seed is needed per acre, depending on the suitability of the soil, the season, quality of seed, etc.

Methods of Seeding.—

On well prepared loam and clay soils broadcast seeding followed by very light discing or harrowing, or both, as the conditions may demand, is all that is necessary. On the lighter, sandy soils however, which will drift or dry out quickly, the seed should be imbedded at a greater depth; this can be accomplished in two ways, viz.: (1) Mix the alfalfa seed with about twice its bulk of dry, sifted soil, fine sawdust or corn meal and sow with the ordinary grain drill, exercising great care however, not to bury the seed deeper than two inches. It is difficult to shut the ordinary drill down close enough so that alfalfa seed alone will not feed out too fast. If this method cannot be used, we suggest, (2) scatter seed broadcast and then disc, using moderate cut only and follow with harrow. These methods, particularly (1) puts the seed down in the soil evenly and provides greater certainty of moisture for germination that when sown in the ordinary way. There is no doubt but that many of the failures in seeding sandy lands are due largely to lack of suitable covering for the seed in soils which dry out quickly.

Nurse Crops.—

As a general rule the young alfalfa plants will succeed much better without a nurse crop. If a nurse crop is used, not more than one-half to two-thirds the ordinary seeding should be applied. Broadcast the alfalfa ahead of grain drill and then harrow, except in the case of clay soils when the alfalfa may be sown after the grain drill.

Clipping.—

If weeds are troublesome, clip high with the mower as often as it is necessary to prevent them from crowding and shading the alfalfa plants and robbing the soil of its moisture. Allow clippings to remain as mulch unless too heavy or, in case weeds have gone to seed they should be removed and burned.

Inoculation.—

Where alfalfa has not heretofore been grown, the soil may need inoculation to develop the production of root nodules, the bacteria of which are claimed to utilize atmospheric nitrogen. If inoculation is desired we recommend the farmer to secure a few sacks of soil from an old alfalfa field and scatter over the soil to be seeded. If the inoculated soil has to be shipped long distances at great expense try from 300 to 400 lbs. per acre; it may be better to use much more however, providing it can be secured near by at little cost. Get soil from fields as free from weeds as possible.

Longevity of Alfalfa.—

In the west there are authentic records of alfalfa stands continuing for ten to twenty years. It is not at all likely that this crop will prove to be as long lived under Michigan conditions. As the stand becomes thinner from various causes, it is crowded more and more by June grass.

Pasturing Alfalfa.—

Great care should be exercised under Michigan conditions relative to pasturing alfalfa. In no case should it be pastured too close by any kind of stock nor trampled excessively so as to injure the crowns of the plants.

R. S. SHAW,
Director.

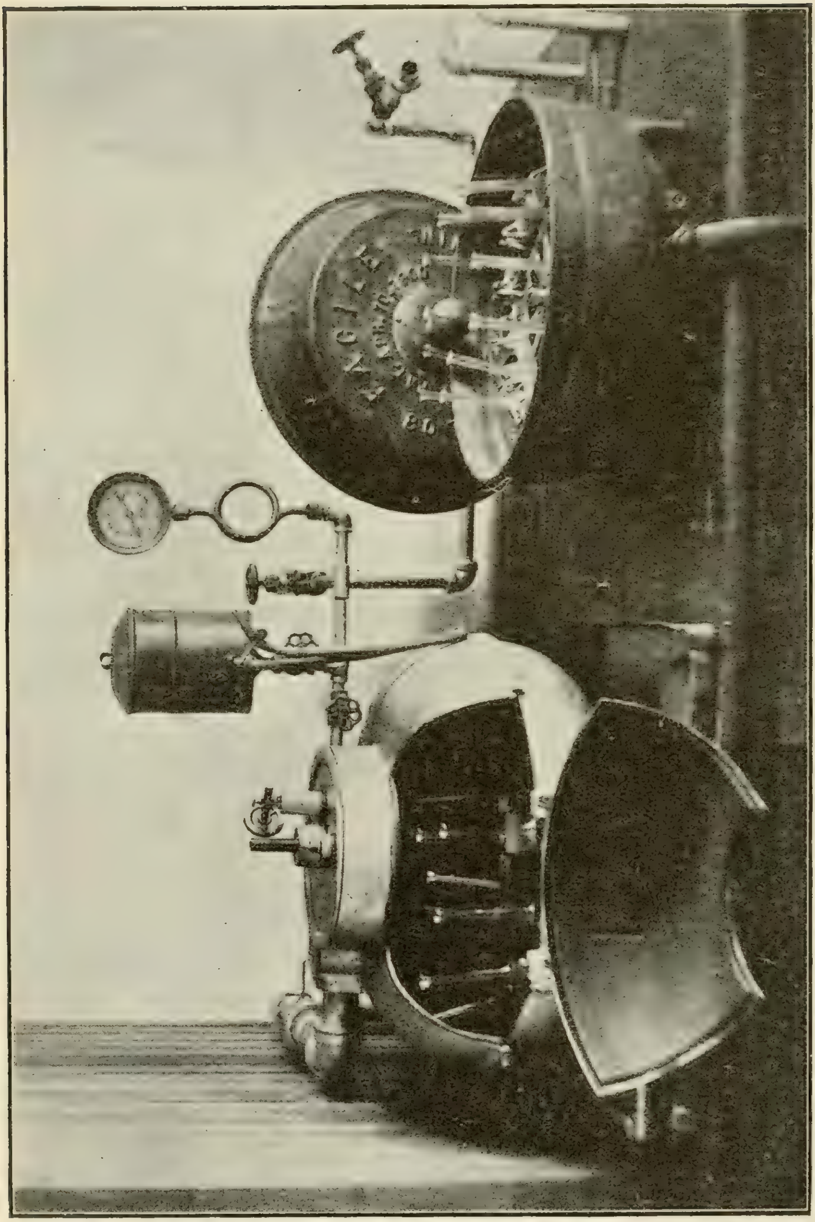

Illustration I.

THE BABCOCK TEST.

Circular No. 2.

The Babcock test is the simplest and most practical method of determining the percentage of fat in whole milk, skim-milk, buttermilk, cream, cheese and whey. Its economic value to the dairy industry can never be estimated. Much of the progress in dairying, in recent years, is due to its discovery and application. The two most important practices resulting from its use are:—

1. The purchase of milk, according to its fat content, has been made practicable.

2. It has enabled milk producers to detect unprofitable cows, thus furnishing an intelligent guide in improving their herds.

APPARATUS.

The apparatus for the Babcock test consists of the following articles:—

1. Babcock tester.
2. 17.6 cc (cubic centimeter) pipette for measuring milk.
3. 17.5 cc acid measure.
4. Sulphuric acid, specific gravity 1.82.
5. Milk, cream and skim-milk test bottles.
6. A pair of calipers or dividers.

Babcock Tester.—

The Babcock tester consists of an encased revolving disc placed in a horizontal position; on the outer edge of this are swinging pockets in which the test bottles are placed. When the machine is at rest, the pockets are vertical, but they assume a horizontal position when it is in motion. The tester is always constructed with an even number of pockets to produce a perfect balance; this is necessary for the smooth and even running of the machine. Illustration 1 shows two styles of Babcock testers. The one shown above *a* is a twenty-four bottle machine operated by a steam turbine and is adapted to factory use. The one at *b* is a twelve bottle hand machine suited to the farm dairy. The tester should be securely fastened to a firm foundation and so set that the revolving disc is level. There should never be any jarring or vibration of the tester when running at full speed.

The speed of the tester varies inversely with the diameter of the revolving disc, that is, the smaller the diameter, the greater must be the speed and vice versa. The necessary speed for a tester is usually indicated somewhere on the machine, denoting, with the power machine, the number of revolutions of the disc and with the hand machine, the number of revolutions of the crank per stated time.

Milk Pipette.—

There are several styles of milk pipettes, the simplest being a glass tube with an enlargement near the center. The pipette should hold 17.6 cc. when filled to the mark on the neck. See illustration 2, figure *c*. At *d* the New-Way automatic pipette is shown consisting of one tube within another; the inner one measures an exact sample and the outer catches the overflow. The Wagner automatic pipette is shown at *c* and consists of an ordinary pipette enclosed at the top with a pear shaped bulb, below which is a stop cock. The part resembling an ordinary pipette takes the sample, the stop cock retains it and the bulb receives the overflow.

Acid Measure.—

There are also several styles of acid measures, each being graduated to hold 17.5 cc. of acid. See ill. 2, figs. *a* and *b*.

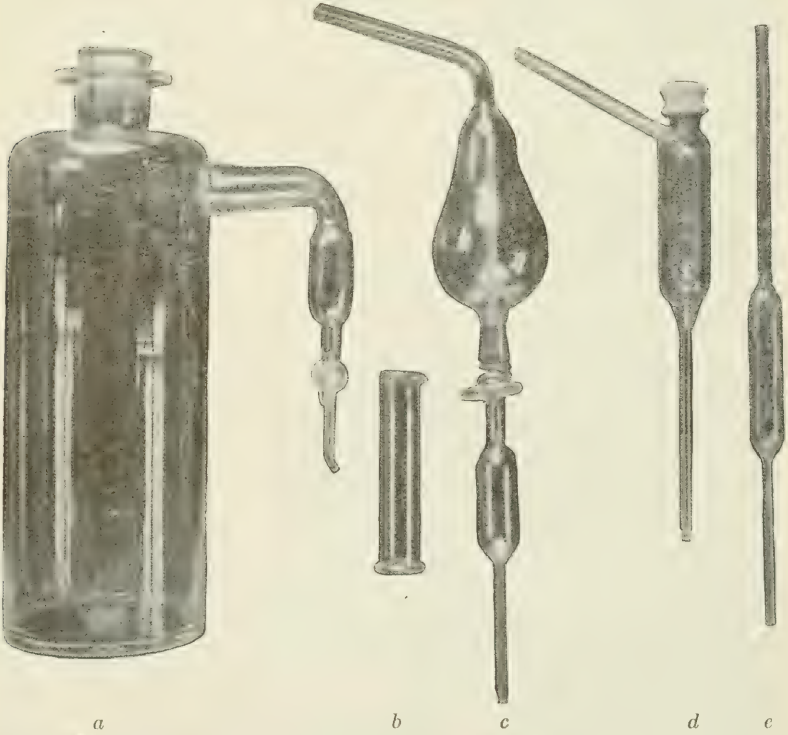

Illustration 2.

The simplest graduated acid measure in use is shown at *b*, while *a* represents an acid storage bottle and measure combined.

Test Bottles.—

Test bottles of the same general style are used in testing whole milk, skim-milk and cream. They differ, however, in the manner in which the neck of the bottle is graduated.

The neck of the whole milk test bottle is marked with a scale graduated to read .2 (two-tenths of a per cent), five of these divisions making one large division which represents one per cent. The graduation extends from 0 to 10%. See ill. 3, fig. *d.*

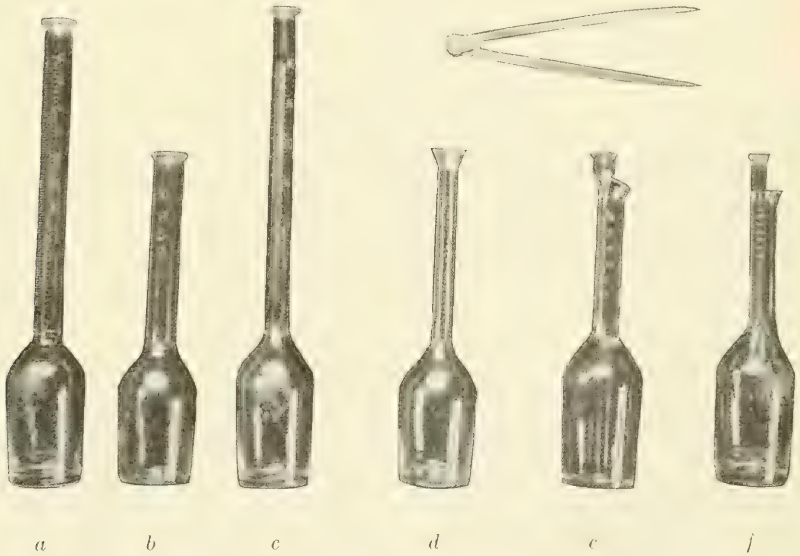

Illustration 3.

The neck of the cream test bottle most commonly used is about six inches long, graduated from 0—30%. The smallest divisions in this graduation are half per cents. See ill. 3, fig. *b.* Some cream bottles, however, are nine inches long and graduated to read quarter per cents, which makes a more accurate reading. See ill. 3, fig. *c.* Figure *a* shows a nine inch cream test bottle graduated to 50%, reading half per cents. These bottles cannot always be used, because they are three inches longer than the ordinary cream bottles and so require a special tester.

Skim-milk, whey and buttermilk test bottles are made with double necks. The milk and acid are delivered through the larger neck while the smaller one is used for the per cent of fat. There are two methods of graduation in skim-milk bottles, one reading to .01 per cent, see ill. 3, fig. *e,* and the other to .05 per cent, see ill. 3, fig. *f.*

Dividers.—

The dividers shown above test bottles in ill. 3 are used for convenience in measuring the fat column.

Acid.—

The acid is sulphuric (H_2SO_4). To be of proper strength it should have a specific gravity of 1.82. Sulphuric acid has a great affinity for water, so it is absolutely necessary that the acid container should be kept tightly closed, otherwise the acid will take up moisture from the air and thus be weakened. It should also be remembered that sulphuric acid is very corrosive and must be handled with great care. If it should get on the skin or clothing, wash off with water and then treat with dilute ammonia.

TESTING WHOLE MILK.

The following are the various steps in testing whole milk:—

1. Mix the sample of milk thoroughly at a temperature of 70° F. by pouring from one vessel to another several times.
2. Measure out 17.6 cc. of the sample with pipette.
3. Transfer the milk from pipette to the whole milk test bottle.
4. Measure out 17.5 cc. of acid at 70° F. and add to the milk in the test bottle.
5. Mix the milk and acid thoroughly with a rotary motion.
6. Put bottles in tester and whirl 5 minutes at the proper speed.
7. Add water at about 130° F. till the test bottle is filled to the neck.
8. Turn the machine one minute more and then fill the bottles up to about the 9% mark with warm water.
9. Turn again one minute and read at a temperature of about 130°-140° F.

Mixing the Milk.—

Fat rises to the surface very quickly if milk is undisturbed, hence it is very essential that the milk should be thoroughly mixed to cause the fat to be evenly distributed throughout. If this is not done the test will not be accurate. In case the cream has hardened or sticks to the side of the receptacle, the sample should be thoroughly warmed and then mixed.

Taking the Sample.—

The 17.6 cc. sample should be taken quickly after the mixing. This is done by placing the lower end of the pipette well down in the milk and withdrawing the air from the pipette by the mouth, thus allowing the milk to enter the tube until it reaches a point somewhat above the mark on the pipette. Then the forefinger is quickly placed over the upper end of the pipette and the milk is slowly lowered to the mark by allowing air to enter at the top. The amount of milk taken weighs 18 grams, which is the weight of samples used in testing any dairy product.

Transferring the Sample.—

In transferring the sample to the test bottle, the pipette is held in a slanting position so that the lower point rests against the inside of the bottle's neck.

Ill. 4, fig. *b*, shows proper position of pipette and test bottle while put-

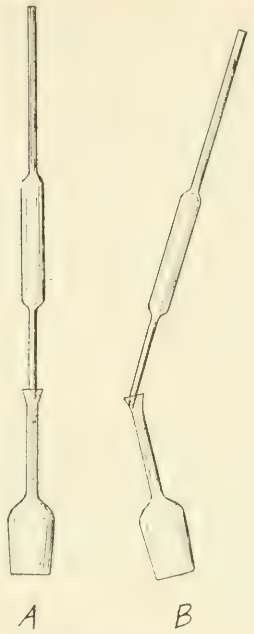

Illustration 4.

ting in the milk, A being improper. Then the pressure of the finger is removed and the milk is allowed to run slowly down the side of the neck into the bottle. Great care should be taken not to lose a drop of milk in the transference as that would lessen the accuracy of the test. It is not intended that every trace of milk should be removed from the pipette because allowance for what remains is made in its construction, for while 17.5 cc. is the required amount for the test, the pipette is graduated to 17.6 cc.

Adding the Acid.—

In adding the acid, care should be taken that it does not pass directly through the milk, as it may then produce a charred fat. The acid should pass down the side of the neck and the bottle should be turned slowly, so that any milk adhering will be carried along.

Mixing the Milk and Acid.—

The milk and acid should be mixed at once with rotary motion and not shaken up and down. The up and down motion tends to lodge hard particles of curd in the neck of the bottle, which causes an inaccurate test.

Revolving the Test Bottles.—

The bottles are placed in the tester and whirled after mixing. It is not necessary that this should take place at once; it may be delayed for 24 or 48 hours without harm. It is better, however, in case of delay, to warm the contents of the test bottles to 160°-180° F. before proceeding with the test.

An even number of bottles should always be whirled at the same time and they should be placed about the disc in opposite positions if the machine is not filled so that the equilibrium of the tester will not be disturbed.

In the case of hand testers, it is sometimes beneficial to put hot water in the jacket during cold weather to keep the bottles warm enough; the water should not rise quite to the level of the bottoms of the test bottles when the machine is at rest.

Adding Hot Water.—

Water used during the test should be at a temperature of about 130° F. The best water to use is that free from minerals, hence rain water or pure distilled water is good.

The object in washing the fat with water twice is to free it from all adhering impurities.

Reading the Percentage of Fat.—

The line of division between the fat column and the liquid beneath is nearly straight, making it easy to read. But the upper surface of the fat column is markedly concave, making it somewhat difficult to determine the proper point at which to take the reading. The correct reading is taken at the line where the extreme upper limit of the fat column touches the side of the neck. See ill. 5.

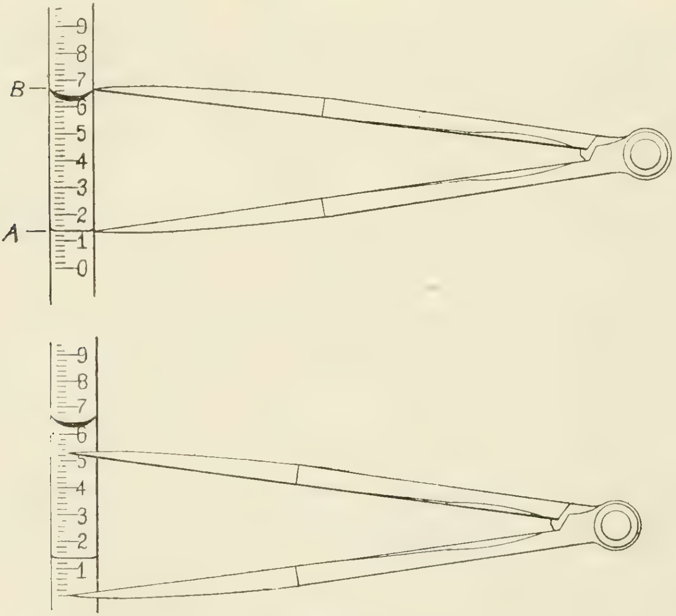

Illustration 5.

Chemists have found that enough fat is left in the bowl of the bottle to make up for the concavity in the upper surface of the fat column.

The length of the fat column is first determined by means of the dividers. These are then removed and one point is placed at the zero mark on the scale of the bottle used, the other point will indicate the exact per cent of the fat in the milk tested.

TESTING CREAM.

The principal point of difference in testing cream and whole milk is that the cream is always weighed. Cream cannot be measured in a pipette for the following reasons:—

1. It is lighter than milk because it contains a higher per cent of fat which is the lightest constituent of milk and because of its viscosity it oftentimes holds large numbers of air bubbles, hence 17.5 cc. of cream would not weigh 18 grams.

2. Cream being viscous, a considerable quantity adheres to the side of the pipette.

Operating the Test.—

1. The cream is first thoroughly mixed.

2. The required sample is then weighed out. In case of a rich cream where a bottle graduated from 0-30% is used, a half sample or 9 grams is taken. If the bottle is graduated from 0-50% an 18 gram sample is used.

3. In case of a 9 gram sample, add one-half pipette of water but do not add any to the 18 gram sample.

4. In both cases, add 17.5 cc. of acid and proceed as with whole milk test.

Reading the Percentage of Fat in the Cream Test.—

In the cream as well as in the whole milk test bottle, there is a marked concavity in the upper surface of the fat column while the lower extremity is nearly a straight line. In reading the fat column, the length is measured from the bottom line to a point half way between the upper and lower line of the concavity in the upper surface. See ill. 6. The whole concave space is not allowed because of the large bore of the neck of the cream bottle.

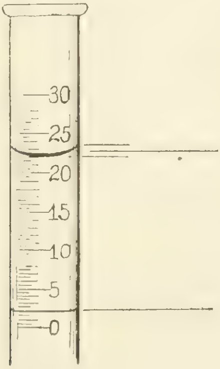

Illustration 6.

When a 9 gram sample is used, multiply the resulting test by two.

METHOD OF TESTING SKIM-MILK, BUTTERMILK AND WHEY.

In testing skim-milk, buttermilk and whey, the double necked bottle previously described is used. With skim-milk and buttermilk the test is carried out exactly as for whole milk, the same quantity of the product being used and the same amount of acid. With whey, the same sized sample is used but only half as much acid. The test is then carried out as for whole milk.

METHOD OF TESTING CHEESE.

Sampling.—

A fair sample of the cheese must first be secured. This can be obtained by either of the following methods:—

1. Procure a narrow wedge shaped segment extending from the outer edge to the center of the cheese. Cut this into very fine pieces by passing it through a meat grinder or using a cheese knife.
2. Secure three plugs from the cheese with a tryer, one at the center, one about an inch from the outer edge and one at a point about half way between the other two. Cut these into very fine pieces as previously described and mix thoroughly.

Testing.—

Nine grams of the well mixed sample is weighed into a cream test bottle. To this is added 15 cc. of hot water and the mixture is agitated until the cheese is disintegrated. If solution proceeds slowly it can be hastened by the addition of a few cubic centimeters of acid. When no more lumps can be seen in the liquid, 17.5 cc. of acid is added and the test is then carried on in the usual way.

The fat column is read as in the cream test and the result is multiplied by two as only a half sample is taken.

DEFECTS IN THE FAT COLUMN.

The following are the defects in the fat column most commonly met with in running a test:—

1. **Black particles** below, through or above the fat column or a darkened appearance of the whole mass. This is due to one or more of the following causes:—
   - (a). Too strong acid.
   - (b). Too much acid.
   - (c). Too high temperature of milk or acid.
   - (d). Allowing milk and acid to stand too long in test bottle before mixing.
   - (e). Allowing acid to drop through milk when poured into the test bottle.
   - (f). Interrupting the mixing of acid and milk after beginning and before completion.
2. **White particles** below, through or above the fat column or a cloudy

appearance throughout, which is due to one or more of the following causes:—

(a). Too weak acid.
(b). Not enough acid.
(c). Too low temperature of milk or acid.
(d). Incomplete mixing of milk and acid.
(e). Uneven or insufficient speed of tester.

3. *Greyish bubbles* on the surface of the fat column, which are generally due to the presence of carbonates in the water added during testing. This condition may be prevented by the addition of a few drops of acid to the water previous to using which precipitates the carbonates.

CLEANING TEST BOTTLES.

It is very essential that the test bottles be well cleaned after being used. If not, the test following is apt to be inaccurate, due to fat particles remaining in them.

After the work is completed, the contents of the test bottles should be emptied into some non-metallic vessel or an earthen jar, but never into anything metallic because of the strong corrosive action of sulphuric acid on nearly all metals. Then they are easily cleaned by washing in a strong solution of some good washing powder and rinsing in clean, hot water. They will become cloudy, however, if cleaned continuously with this, so it is necessary about once in every five tests to use a solution of potassium bichromate.

The potassium bichromate solution is prepared by dissolving potassium bichromate crystals in warm water, making a saturated solution or one in which the water has as much of the substance in solution as possible. To this is added one-tenth of its volume of sulphuric acid, such as is used in testing. In cleaning the test bottles about 10 cc. of the solution is put into each one; the contents are then heated to a high temperature by placing the test bottles in water which is near the boiling temperature; the test bottles are then shaken until absolutely clean, when the solution is emptied into some receptacle for future use and the bottles are rinsed with hot water; during the rinsing a test bottle brush is used to insure cleanliness of the bottle neck.

The potassium bichromate solution may be used several times or until its cleaning properties have been entirely used up.

COMPOSITE SAMPLES.

A mixture of samples of milk taken from day to day is known as a composite sample. This is done to obviate the great amount of work involved in making daily tests. A jar, usually a pint "Lightning" tin top milk bottle, is provided and in it is placed a small sample of each day's milk, whether it be that from a creamery patron or from the product of individual cows. Into this is put some preservative to keep the milk sweet up to the time of testing. The fat test gives the average percentage of fat in the milk for the period covered by the mixture of daily samples.

Taking Samples.—

Great care should be exercised that the small samples taken are an accurate and an aliquot part of the whole. To be so the milk should be thoroughly mixed and some device should be used in taking the sample that will take a corresponding part of the whole each day. If the quantity of milk varies but little from day to day, a half ounce dipper can be used to advantage, but where there is a considerable variation in the quantity, a sampling tube is much more accurate.

The sampling tube, of which there are many styles, consists principally of a long, hollow, metal tube which is let down into the milk to the bottom of the receptacle and when filled is drawn out. This gets a uniform proportion of the milk as it takes a sample corresponding to the amount of milk in the receptacle and it also provides a strictly representative sample of the milk, as it takes a uniform amount from each layer.

Preservatives Used.—

The following preservatives have been found best to use in composite sampling:—

1. Corrosive sublimate.
2. Formalin and
3. Potassium bichromate.

Corrosive sublimate is the most satisfactory for general use, being a more powerful antiseptic than either of the others. It is put up in tablet form and being deadly poison, it is colored pink, which warns people against using any of the milk in which it is put. One tablet will preserve one pint of milk at least two weeks in warm weather.

Care of Composite Samples.—

1. Composite samples should be kept covered tightly to prevent evaporation of water which would tend to make the fat test higher than it normally should be. Also, the evaporation may cause the formation of a tough cream, rendering difficult the taking of a good sample for testing.

2. The containing jar should be shaken each time a sample is added, otherwise cream will come to the surface and where it comes in contact with the sides of the bottle, forms a tough layer, rendering sampling difficult.

3. The sample should be kept in as cool a place as possible, so that no more preservative than is absolutely necessary need be used.

When to Test.—

Composite samples should not be carried along more than two weeks without testing. If they are kept longer than this, it is nearly impossible to get a perfectly reliable fat test. Patrons of a creamery where the samples are tested only once a month have a legitimate right to object to the results.

Testing Composite Samples.—

When the composite sample is to be tested, it is treated according to directions for testing whole milk.

W. B. LIVERANCE,
Instructor in Dairying.

CORN.

SELECTING, STORING, CURING AND TESTING FOR SEED.

Circular No. 3.

In order to secure the largest possible yields of corn, including grain and fodder, the grower must carefully and intelligently select, cure, test and grade his seed corn. It is true that many farmers obtain their seed corn from the crib in the spring and secure what appears to be good stands and reasonably good crops. This does not mean, however, that the stand might not have been made better and the crop larger had these same farmers given more care to the selection, storing and treatment of their seed corn. The condition of corn, in the spring of 1908, that had stood during the winter in shock or crib emphasizes in a striking way the risks that are run in using seed that has not been properly saved. Of a large number of ears tested at the college for vitality, those selected from the shock invariably produced an exceedingly low number of germinations. More than 50% of the ears produced no germination whatever, and of those that did show vitality it was rare that 100% of the kernels germinated. The conditions under which corn passed the winter were exceedingly bad, but even with the best conditions, there are influences, such as freezing, molding, and the like, which of necessity

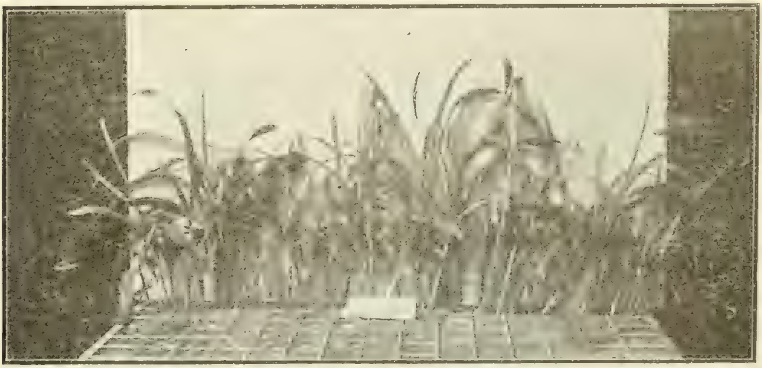

FIG. 1.—The plants from 15 ears of carefully saved seed corn, in germinator test.

tend to reduce the vitality of the corn. See figs. 1 and 2. Years of experience are proving that the men who have produced the largest yields and the most valuable breeds of corn, are those who have exercised a large degree of care in the selection and handling of the seed.

This circular has been prepared for the purpose of setting forth some of the most important points in the selection and handling of seed corn.

SELECTION.

In Michigan corn is grown both for grain and fodder. It becomes important, therefore, in the selection of seed to consider the stalk from which the ear is selected, as well as the ear itself. Hence, the ear should be selected while it still remains upon the standing stalk. The stalk from which the ear is selected should be of good size with a considerable amount of foliage.

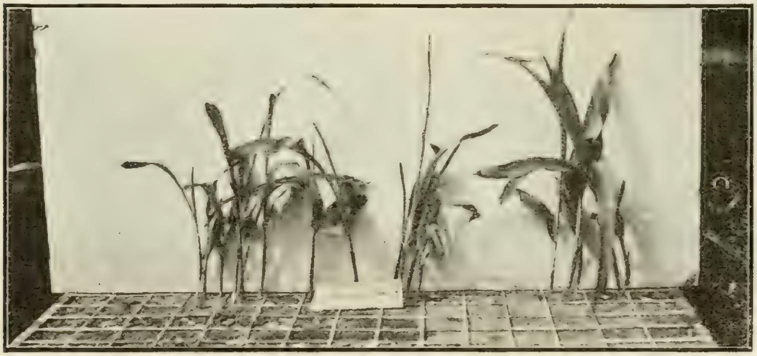

FIG. 2.—The plants from 15 best ears selected from crib in spring 1908, in germinator test.

Position of the Ear.—

The position of the ear on the stalk should be considered. It should not be too high, for it is claimed that the higher the ear, the later it matures. Moreover, the weight of the high growing ear increases the tendency of the stalk to fall in stormy weather. The ear should not be too low for there is then danger of its being knocked off by the harvester.

Recent experiments seem to indicate that the location of the ear on the stalk can be controlled by the careful selection of seed ears properly located on the mother plant. The ears should have a pendant attitude, for if they stand erect rains are apt to beat in upon the tips between the husks, and result in molding the grain.

Two Ears on the Stalk.—

There is a difference of opinion as to whether corn for seed should be selected from stalks bearing two ears, and whether it is possible by selecting such ears to secure increased yields in future crops. The writer is inclined to the opinion that increased yields are procured by the judicious selection of seed from stalks bearing two ears.

Size and Shape of Ear and Kernels.—

The ideal ear of corn, see fig. 3, should be cylindrical rather than tapering in shape: for Michigan conditions, when dry, the ear should be about nine inches long and seven inches in circumference, but the smaller breeds will fall somewhat short of these dimensions. The kernels should be deep and slightly spaced between rows, see fig. 4, and should be well filled at butt and tip.

Depth of kernel is indicated not only by the weight of the ear but also by the degree of roughness of the top of the grain. The experienced corn breeders of the country are strongly favoring and developing rough-top kernels even among the breeds of corn that were originally smooth. Ears as ordinarily secured from the stalk in the fall will shrink as much as 10% in both length and circumference.

Maturity.—

Seed corn should be selected from stalks that mature just before the average time of the first frost which, in Michigan, occurs about the 15th of September. Corn that matures earlier than this fails to use all of the growing season, while that which ripens later is injured.

Removing, versus Marking Ears.—

Some farmers select seed ears by removing them from the standing stalks, but a number of progressive corn growers and some investigators, indeed, now hold to the opinion that corn that is to be used for seed should be allowed to remain on the stalk until husking time and offer the reason that corn removed from the stalk at an earlier period is lacking in vitality. In case this practice is followed, each ear selected is marked by tying upon it a bright string. The stalks bearing these marks are cut and shocked with the balance of the crop, and at husking time the marked ears are saved by themselves.

Selection at Husking Time or from Crib.—

Some farmers follow the practice of selecting seed at the time of husking, in which case the best ears are set aside regardless of the character of the stalks upon which they grew, or the position and attitude of the ear upon the stalk. Though not commendable this is undoubtedly a much better practice than selecting ears from the crib the following spring. Experience demonstrates that the best results only can be secured when every phase of careful selection has been observed. On large farms it is sometimes the practice to select a sufficient amount of seed corn in the manner above described, to plant a portion of the field, and from this portion seed for the following year is selected, both from the stalk and from the shock at the time of husking.

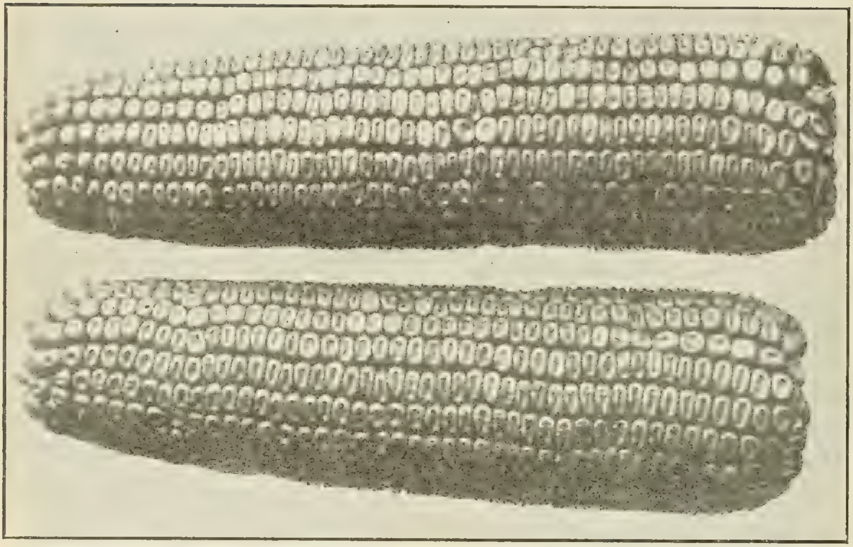

FIG. 3.—Two Michigan grown ears of Ried's Yellow Dent.

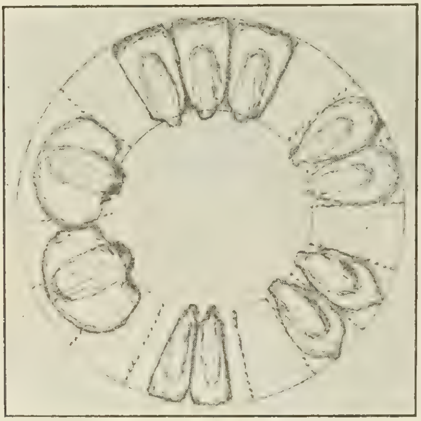

Fig. 4.—A study of kernels.

The upper three kernels are well proportioned and occupy completely the space between the circumference of the ear and the circumference of the cob.

The upper right hand two kernels are poorly shaped and leave a lot of unoccupied space.

The lower right hand two kernels show how the white rice popcorn kernels occupy the space.

The lower two kernels are of the shoe-peg type.

The left two kernels show the relative shape and position of flint kernels as compared with the upper three dent kernels.

CARING FOR THE SEED.

Storing and Drying Seed.—

The selected ears should be placed where they will dry in the shortest reasonable time and various methods have been employed for this purpose. There is no better method from the standpoint of efficiency than the old one of braiding the ears together by the husks left upon them or tying them in lots by strings and hanging in the summer kitchen or in the attic above near the stovepipe. This, however, requires considerable room and is not altogether satisfactory to the workers in the kitchen. A furnace room is a good place, providing it is well ventilated and an occasional fire is built. Frequently the corn is left in crates and while this is usually a successful method, there is more or less

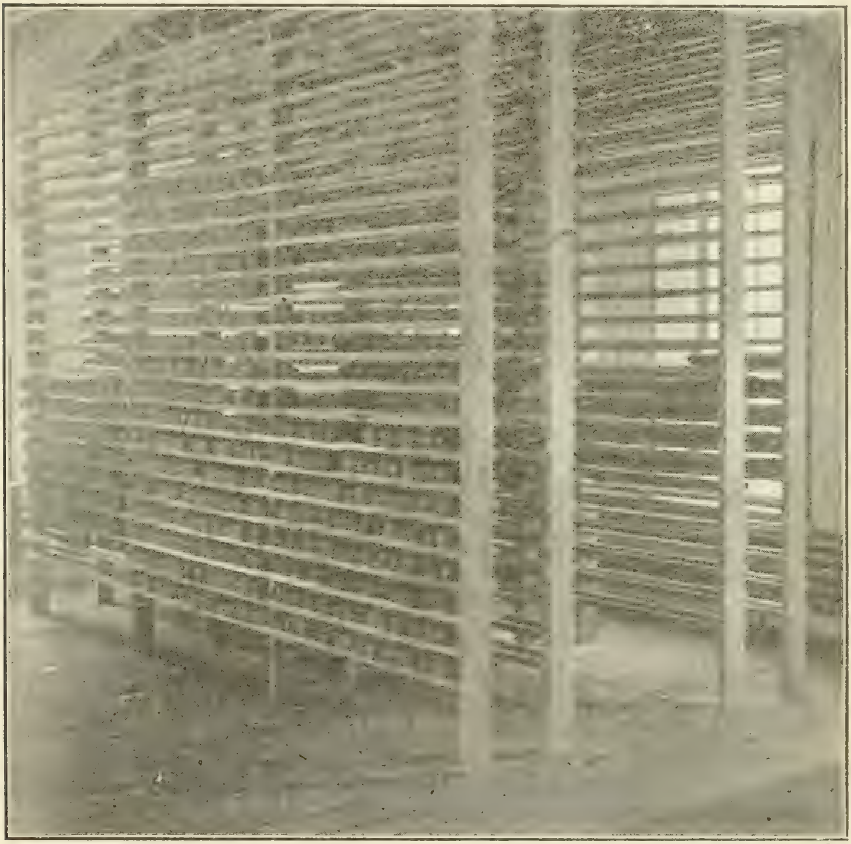

FIG. 5.—A practical rack for drying seed corn.

danger from molding; corn so stored should be watched carefully until it is known to be thoroughly dry.

The College Corn Rack.—

Figure 5 shows a cheap rack used at the college for storing and drying seed corn. It is 12 ft. long and 10 ft. high with capacity for 30 bushels of ears. The posts which are 2x4 inch hemlock, stand four feet apart. The horizontal strips 1x⅞ inches may be cut from sound hemlock or pine boards. They are set in pairs four inches apart, each pair carrying a tier of corn. Six-penny nails should be used in nailing on the strips.

Convenient Contrivances.—

Figure 6 shows a convenient method of storing corn for drying. This is a plan devised and brought to our attention by Mr. Orin J. Bemis, of Ypsilanti. Figures 6 and 7 show the individual appliance and also a number of them filled with corn and suspended for drying.

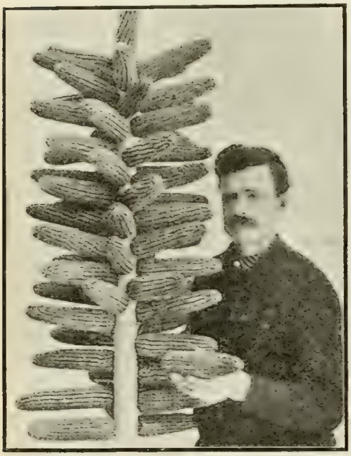

Fig. 6.—The Bemis rack with corn in place.

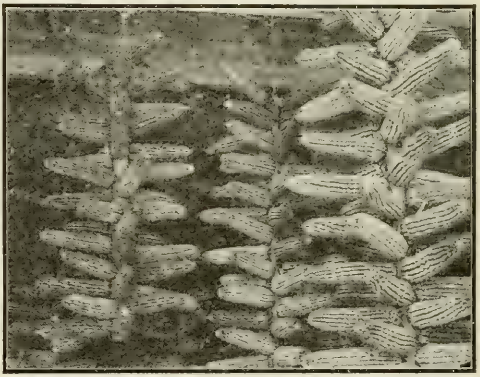

Fig. 7.—Bemis racks filled with corn and suspended from joists.

Figure 8 shows another device termed the fence post rack also devised by the party above mentioned.

Suspending Corn with Twine.—

Figures 9 and 10 show a very simple method of tying corn into lots by the use of binder twine. This is a plan that is suggested by Professor Holden of Iowa.

The foregoing methods have been suggested because they are simple, inexpensive and efficient.

Drying.—

The temperature of the room in which corn is stored should be maintained at seventy-five or eighty degrees, with abundant circulation of air. Rapid drying removes the possibility of molding and consequent loss of vitality. After the drying is complete, the temperature of the room may be allowed to drop even below freezing, but it should be observed that many of our successful corn growers never allow the temperature of the room in which seed corn is stored, to fall below freezing. The room should be kept thoroughly dry.

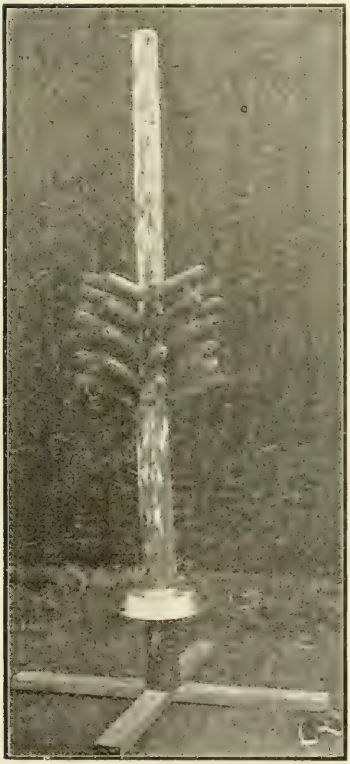

FIG. 8.—Corn rack made of a fence post.

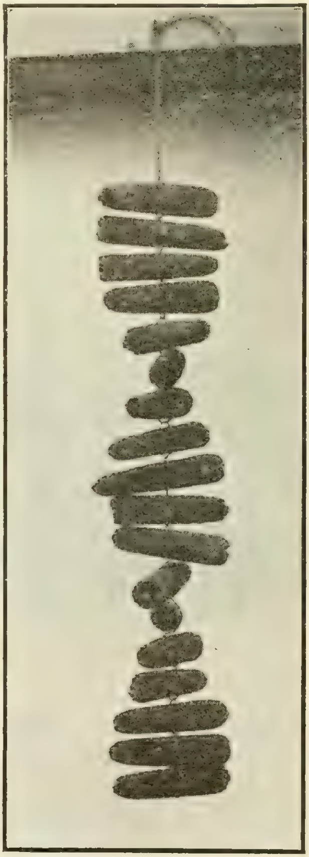

FIG. 9.—Seed corn suspended by binder twine.

TESTING SEED CORN.

In addition to selecting and drying seed corn every ear should be thoroughly tested before being shelled for seed. The undertaking is not burdensome.

Germinator.—

Figures 11, 12 and 13 show the germinator used by the Farm Department at the college. It is made of galvanized iron and is 11¼ inches by 17½ inches, inside measure, and is one inch deep. Notches are cut 1¼ inches apart in the edges of sides and ends. The germinator is filled with sand or sandy soil, and struck off with a straight edge, and then tapped slightly to settle the soil. Strings are then stretched as shown, marking 1¼ inch squares. This makes nine rows having fourteen squares each and a total of one hundred and twenty-six.

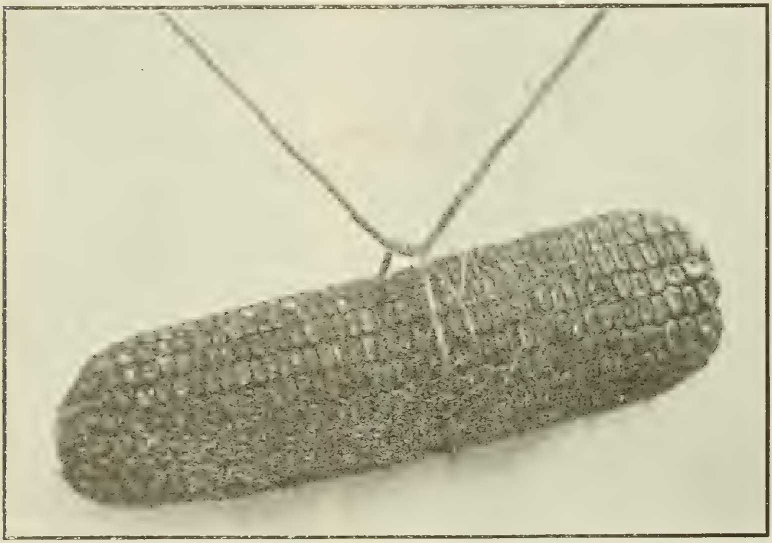

Fig. 10.—Shows the manner of tying the ears together with binder twine.

Home-made Germinator.—

Any boy can make a germinator of a drygoods box that will work perfectly. See fig. 14. Drive tacks or very small nails into the upper part of the sides and ends (below the edges), 1¼ or possibly 1⅜ inches apart to attach the strings.

Arranging Ears for Test.—

Arrange systematically the ears of corn in rows, on racks or floor, to correspond with the rows of squares in the germinator. By so doing each ear will have its corresponding square, and bear a similar number

Placing Seed in Germinator.—

From ear one in the first row, remove four kernels from as many different points on the ear and set these kernels small end down and germs in, in the first square. Press each kernel down until its top is even with, or better, just below the surface of the sand, as shown in fig. 11. In like manner, remove kernels from each ear and place them

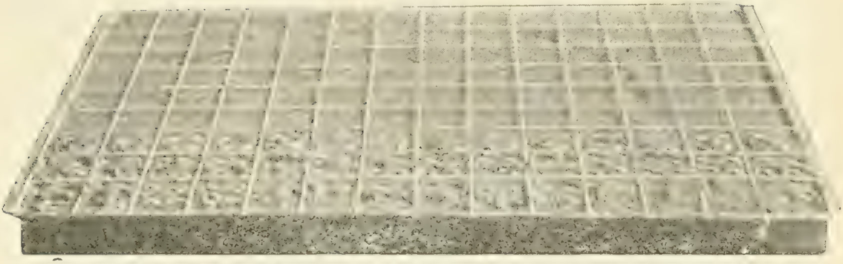

FIG. 11.—Galvanized iron germinator. Small notches are cut in the rim at intervals of 1¼ inches to carry the string or wire which divides the germinating surface into 1¼ inch squares. This figure shows four rows of kernels in place.

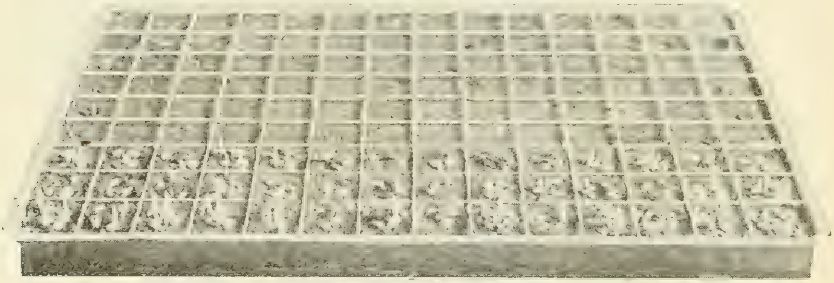

FIG. 12.—Same as figure 11, after four days.

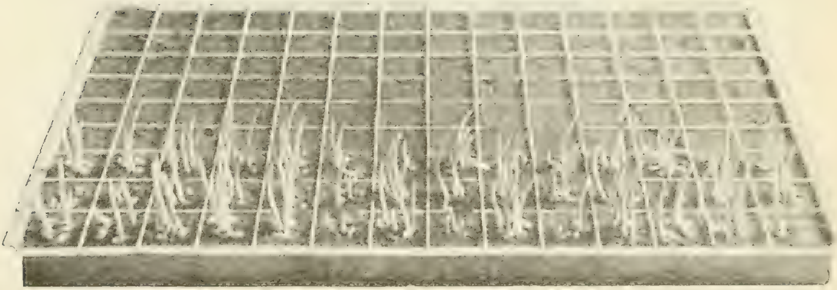

FIG. 13.—Same as figure 11, after seven days.

in the corresponding square of the germinator. When the squares in the germinator are filled with kernels, wet the sand thoroughly and set in a warm place at room temperature, or slightly above. See that the sand is kept well moistened but not saturated.

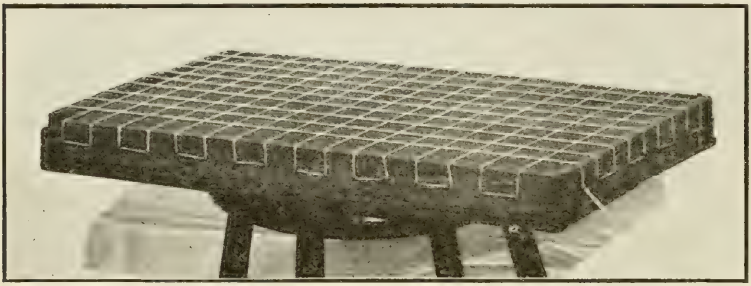

FIG. 14.—Germinator made from a soap box, ready to receive the kernels from ears.

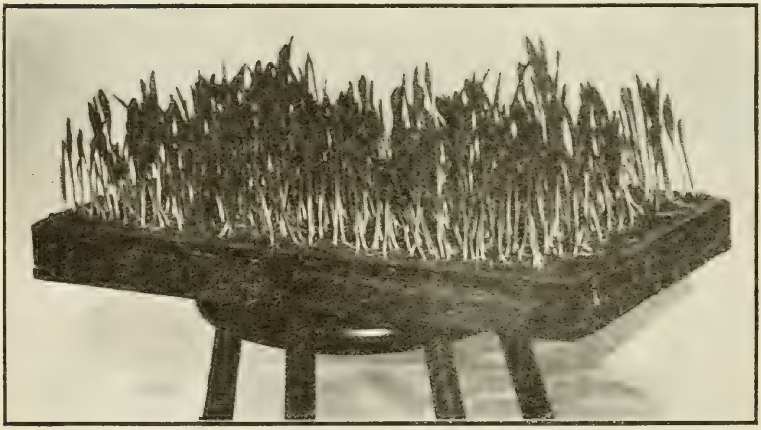

FIG. 15.—Germinator made from soap box with plants sufficiently developed to indicate the quality of the ears from which the kernels in the test were taken.

Period of Germination.—

Figure 11 shows the corn in place. Figure 12 shows the corn just appearing and figure 13 shows the corn seven days after planting. It is not until the corn has reached the height of three or four inches and thrown out two or more leaves, that one can judge well of the quality of the seed. See also figure 15.

Detecting and Discarding Weak Ears.—

Examine each square in order. If in any square, any of the kernels have failed to germinate, discard the ear corresponding to the square. If in any square all of the kernels have germinated, but one or more of the young plants show a lack of vigor, discard the ear corresponding to the square. In this way every ear having kernels of low vitality is rejected.

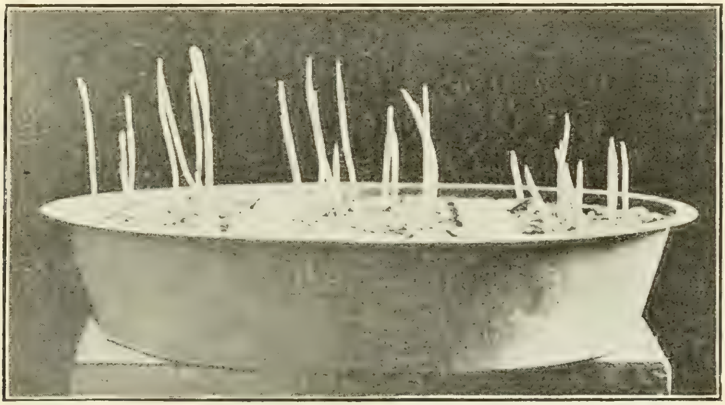

Fig. 16.—The young plants at the left are from tip kernels, those in the middle are from middle kernels, and those on the right are from butt kernels, all from the same ear, and planted at the same time.

TIP AND BUTT KERNELS.

Discard Moldy Kernels.—

The tip kernels should always be removed back sufficiently far to be sure that no moldy kernels remain. These kernels, while the ear is still in the husks, are liable to develop mold, and moldy kernels are nearly always deficient in vitality. In practice it is common to remove butt and tip kernels where the planting is to be done by a machine. The opinion prevails that tip and butt kernels should be removed because of the effect their planting may have upon the size of the grain of the future crop. In the majority of a considerable number of tests made by the writer, the tip kernels were found to germinate more quickly and the butt kernels more slowly than the middle kernels. In some breeds this order appears to be changed. A careful study of all the facts would indicate that the rational thing to do, were it not that our corn planting machinery requires a uniform size of kernels for efficient work, would be to plant all the kernels of the ear tips, middies and butts. See figs. 16 and 17.

GRADING.

The question of grading corn has already been referred to in the paragraph above. As indicated, it is common practice to remove tip and butt kernels for the sake of uniformity in size of seed for planting where the planter is used. It is also coming to be a common practice to further grade the corn by the use of screens, separating the corn into two or three grades and then selecting a size of plate for each grade of corn respectively. It will readily be seen, that a plate hole of proper size to receive the medium kernel might receive two of the smaller kernels and would not receive one of the largest kernels. But, in the case of planters having plates with holes to carry three kernels instead of one, if the hole were of sufficient size to carry three medium kernels it would carry five or six of the smallest and possibly but one of the largest. This would result in the case of ungraded corn in a very irregular drop, and therefore, in a very irregular stand.

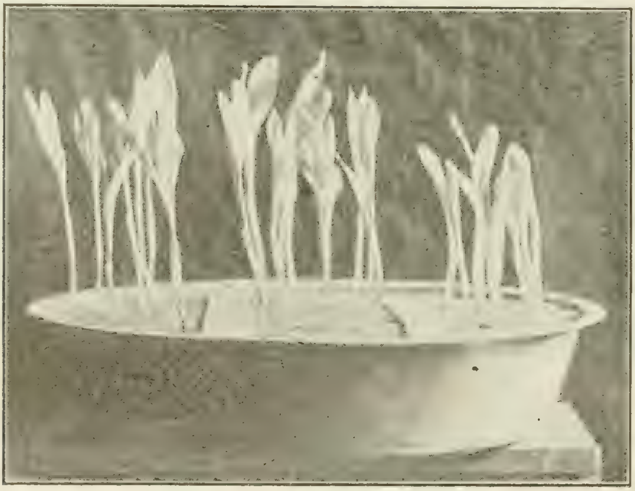

FIG. 17.—Same as figure 16, after four days.

J. A. JEFFERY,
Professor of Agronomy.

Circular No. 1 contains information relating to alfalfa growing with brief notes concerning suitability of soils, cultivation, seeding, fertilizing, etc. Circular No. 2 describes the use of the Babcock test in determining the percentage of fat in whole milk, skim-milk, buttermilk, cream, cheese and whey. Copies of these circulars will be furnished free of charge upon application to the Secretary, East Lansing, Mich.

R. S. SHAW,
Director.

METHODS OF BREEDING FOR THE IMPROVEMENT OF MICHIGAN CATTLE.

Circular No. 4.

This publication has been prepared to call attention to the urgent need for the adoption of improved methods of live stock breeding in Michigan, to discuss practical and applicable methods of accomplishing the same and to present specific plans within reach of the stockman and farmer. The first part deals with methods of improving Michigan cattle as described in bulletin 241, now out of print, and the last part with the establishment of co-operative breeders' associations.

According to the last state census, dated July 1st, 1904, there were 1,744,510 cattle in Michigan, at that time, valued at $36,374,877. The exact percentages of registered, cross-bred, grade and scrub cattle are not known, but as not over 1 per cent of the cattle in the United States are registered, Michigan probably does not possess more than her share of these. The total number of pure bred cattle must be small as not over 1,500 names of Michigan cattle breeders appear in the various herd books and some of these undoubtedly possess but one registered animal, viz.: a bull. Of course there are some possessed of animals eligible for record whose names do not appear on the books.

This publication is not addressed to those engaged in pure-bred live stock breeding, but is intended for the great majority in possession of the cross-bred, grade and scrub. The fact that a man owns and is using pedigreed animals is sufficient evidence that he is interested in live stock improvement and is familiar with and practising good methods of breeding. Our producers of registered stock do not receive the support and encouragement they should, for after expending large sums of money to secure good foundation stocks and years of effort in establishing good herds, their offerings of surplus stock, especially males, do not find a ready sale at sufficiently remunerative prices. It cannot be denied that good bulls are slow sellers in Michigan. The average producer of meat and milk (not breeder) seems determined not to pay more than about meat prices for registered bulls to infuse improved blood in his herd, but the breeder cannot afford to produce them at such prices. Failing to secure improved males at these low prices many producers fall back on the grade, or even the scrub and frequently combine with this in-and-in breeding, especially where the males are chosen from within the herd.

Because the producers of live stock other than pure-breds comprise such an overwhelming majority of stock owners, and because they produce the great bulk of the animal products marketed, their influence in determining the character and reputation of Michigan meats and milk is very far reaching. It is in the hands of this class that the scrub and animal of badly mixed breeding are to be found.

INFERIORITY OF THE COMMON STOCKS.

The chief fault of the common cattle of Michigan is their lack of quality and uniformity; this is due both to a need of good blood and also to the indiscriminate admixture of the blood of breeds of both beef and dairy types. Proofs of these assertions can be secured by observation. In traveling about the state by wagon road or rail, note the number of animals in each herd, also the variation in type, form, and more particularly color. Except for the herds of the few breeders of pure-bred or high-grade cattle, the common bunches will be found to contain a great variety of color and types. In many herds, red, white, black, brindle and all conceivable combinations of these colors are to be found; at the same time individuals will conform in a measure to strictly beef form, others quite markedly to dairy form with all gradations between the two. Breed indications as shown by color will undoubtedly attract the attention of the casual observer more readily than other features. This lack of uniformity prevents the use of economic methods in any specific line of production and prohibits the best results in marketing.

A large percentage of the best cattle now being fed in Michigan by good feeders are secured from western stockyards because it is difficult to secure feeders of quality and uniformity at home; the culls have to be purchased along with the better ones.

Close inspection of consignments of cattle from this state is not necessary to convince one of their lack of breeding.

SOME CAUSES OF LACK OF BREEDING IN MICHIGAN CATTLE.

1. Lack of infusion of good blood.

2. The indiscriminate admixture of the blood of the various breeds has been one of the most direct causes of the production of inferior stocks. This has not been restricted to the breeds within the beef and dairy classes, but includes admixture of the blood of the two classes. With the rise in prices of dairy products, the common cows have been bred to dairy bulls; with depreciated values for dairy products, these same cows and their female progeny have been bred back to beef sires, and so on. There are also numerous instances in which herds made up of cows of small types producing a small flow of rich milk have been bred to bulls of a larger breed noted for heavy milk flow, and vice versa.

3. Another potent force tending toward the production of inferior cattle is found in the prevalent use of grade and scrub sires. According to the last state census there were 27,800 bulls one year old and over in Michigan in 1904, valued at $805,932.00 or an average of $28.90 each. This same report puts the average value of our three year old steers at $34.78 per capita, exceeding our average bull values by $5.88 per head. There are too many animals in our yards today sired by bulls bred to females for no other purpose than to freshen them again.

So far as external form and indications of quality are concerned, a high-grade sire may look equally as good as a pure-bred one, and still this is no justification for his use. Though an animal may be an exceptionally good individual, if he is lacking in prepotency, as the grade derived from mixed blood on the dam's side is sure to be, his offspring cannot equal those of the pure male. Grade bulls should not be used until all pedigreed ones have first been brought into service and their usefulness extended as far as possible.

PLAN FOR LIVE STOCK IMPROVEMENT.

Before introducing the plan of live stock improvement known as up-grading, we wish to state that it should be the ambition of every man owning live stock to eventually get into some line of pure-bred live stock breeding. The plan we have to suggest and discuss for the improvement of the common stocks of the country, is that known as up-grading, which consists in ingrafting the characteristics of a superior breed upon animals of common, or mixed breeding, for the purpose of improving them. This improvement is due to the superior quality of the males used, and chiefly their prepotency, or power of transmitting accurately these qualities to their offspring. This plan differs from cross breeding, in that pure blood is used on the sire's side, and females of mixed blood, or no blood, on the dam's side. Thus we have the prepotency concentrated in the bull, and the very opposite in the females, as the more mixed the breeding, the less stable are the inherent characteristics of the individual, and therefore the less resistant to improvement. It would be absolutely impracticable to advise all owners of common cattle to send their stocks to the block and purchase pure bred foundation stocks; only a few could do this for the following reasons: First, if the great majority now possessed of common stocks were to simultaneously seek to purchase pure bred foundation stocks, they could not get them, they are not in existence, for only about one per cent of the cattle in the United States are possessed of pedigrees. Second, the finances of a great many holders of common stock are not such as to allow them to make extensive purchases of pedigreed animals, and replacement is out of the question, as it would require the returns from the sale of three or four common animals to purchase one pedigreed one. Third, it is highly desirable for breeders to grow into any line of pure breeding rather than to buy into it suddenly, and take up a work in which experience is necessary.

In general, then, it is necessary for the majority of holders of common stock to make the best use of the animals on hand, with a view to improving them. Let us suppose the case of a herd of common, or mixed cattle of say eighteen head, and apply a plan of improvement. The first thing for the owner of this herd to do, is to decide upon some one line of production, either beef or dairy, and then stand by the resolution. Without this he cannot improve his herd, for the animals of mixed breeding are largely the result of frequent change of purpose. Suppose in this case, that the owner has decided to go into the dairy business; that being the case, the next thing to do will be to look over the herd of eighteen, and decide which ones are so possessed of dairy type and characteristics as to warrant their being used in the business They can be divided into three classes, such as best, medium and inferior, from a dairy standpoint. Then, in the majority of cases, it will be found to be a decided advantage to send the six inferior ones to the block and use the remaining twelve for the foundation herd. Having selected the females to be retained, the next and one of the most important steps is to decide upon the breed to be used in improvement.

In this, adaptability of the breed to the conditions, and the question of personal preference, are the two important factors; the decision of this question is also an important factor, for a change of mind after the work has begun, and the use of other blood, is more apt to result in retrogression for a time, than improvement. Having decided upon the breed to be used for improvement—suppose it is the Holstein—then purchase the best Holstein bull that the pocket book will allow. Mate this bull with the twelve selected cows, and use him for two seasons, after which his progeny will be old enough to breed. At this point secure another Holstein bull, a better one than the first if possible; follow him with others of the same breed, indefinitely. Let it be Holstein bull after Holstein bull, nothing but Holstein bulls. We have cited the Holstein merely for the purpose of this illustration. The same plan must be used no matter what the breed is.

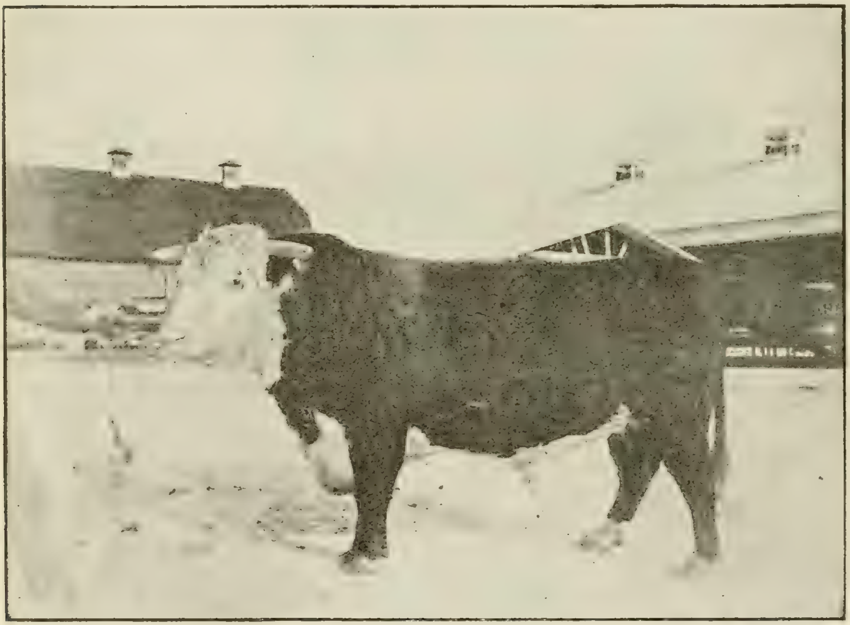

ILLUSTRATION 1.
Hereford—Kington 2d 134454. Sire of heifer illustration 3.

We may expect, after a few top-crosses in up-grading, that the progeny will resemble the type of the sires used in improvement, quite closely, both as to form and general characteristics; in fact, so much so that the high grade may eventually equal the pure blood improver from a standpoint of utility in meat or milk making, as the case may be. There is some question as to the number of crosses that must be produced before this high standard of excellence will be secured in the grade. See result in first generation from mating Hereford sire with scrub cow, illustrations 1, 2, and 3. This will be somewhat dependent on the duration of the

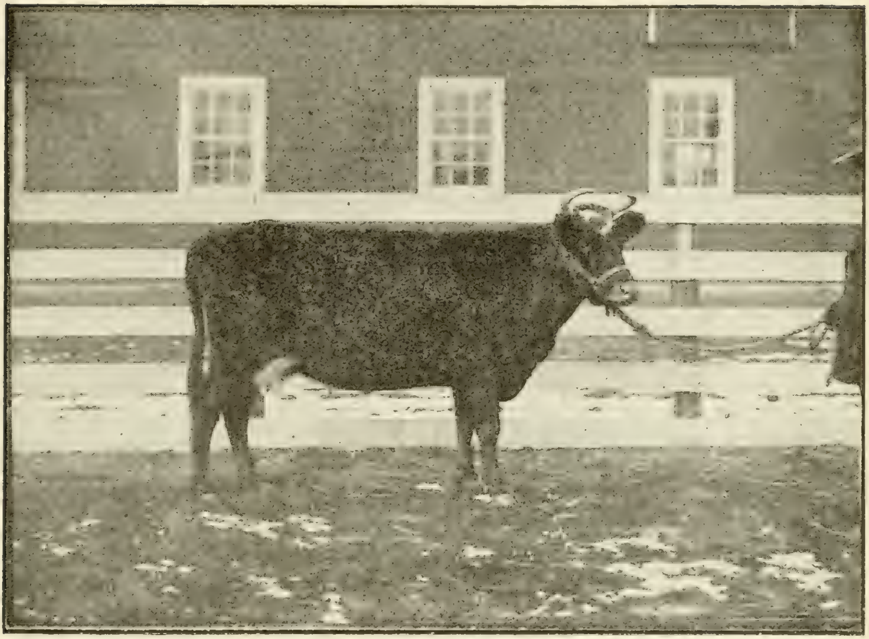

ILLUSTRATION 2.
Scrub cow—Dam of heifer illustration 3.

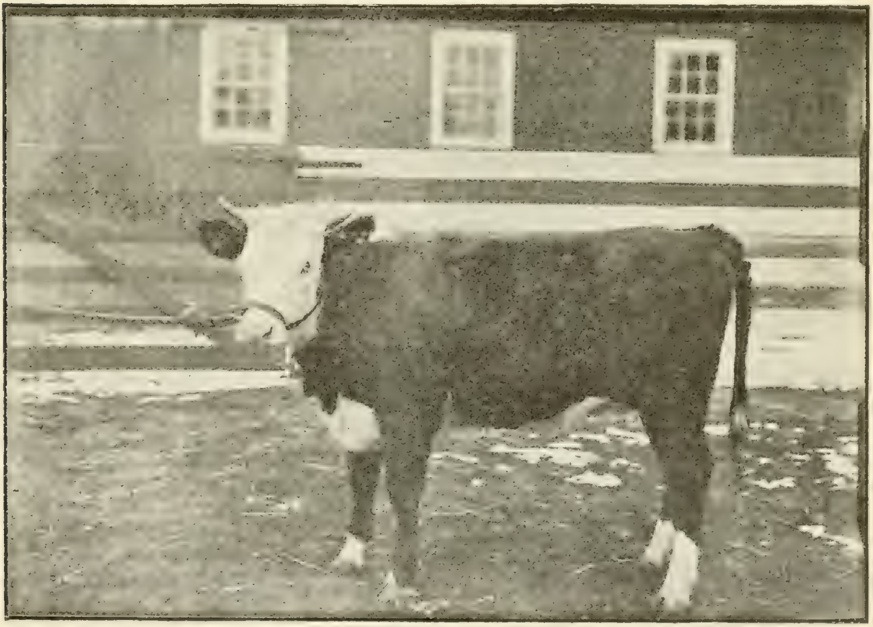

ILLUSTRATION 3.
Grade heifer—12 months old. Sired by Kington 2d, and out of scrub cow.

purity of the improving blood, the prepotency of the individual sires, and the plasticity of the common females. Instances are on record where ideal high grades have resulted from the third cross; in general, one would be safe in counting on at least the fifth. We must not, however, lose sight of the fact that while a high grade may eventually equal the improving breed from a standpoint of meat or milk making, that it can never be possessed of a pedigree, nor equal the full bloods from a standpoint of prepotency in breeding; this is the principal argument used against grade sires.

We also suggest that at the time of the purchase of the pure bred sire, one cow, or possibly two of the same breed be secured. The progeny of these two or three registered animals should grow into a nice little herd at the end of ten years, which could be used to replace the poorer of the high grades. That the high grade can be successfully produced as described, cannot be disputed, and its values have already been clearly demonstrated. The high grade forms the bulk of the western feeders coming to our feed lots; it makes up almost the sum total of the 400,000 prime steers which annually cross the Atlantic; it has occupied no mean place in the list of awards in fat classes at state, national and international live stock shows.

We desire at this point to emphasize the fact that the use of improved methods of breeding alone will not avail; it is absolutely necessary for these to be supplemented by liberal feeding and proper care and management.

METHODS OF ORGANIZATION.

Following the discussion heretofore presented and the generally conceded need of live stock improvement, it seems highly desirable that some practicable plan should be adopted to stimulate the general use and perpetuation of improved methods.

Attention has been directed to the fact that the continued admixture of the blood of different breeds has resulted disastrously. At the present time, in most instances, there are too many breeds in a given locality, thus facilitating admixture. It is true that individual likes and dislikes vary greatly, but it nevertheless seems to be the case, that if one man introduces a certain breed, his nearest neighbor will at once introduce another, apparently for no other purpose than to have something different, whereas, if they were both using the same breed it would work to their mutual advantage. Marked advantages accompany unity of purpose and methods and community interests in breeding. The greatest success that has been achieved in the history of animal breeding has resulted where there were harmonious community interests and but one principal line of breeding. To illustrate, Jerseys only have been bred on the Isle of Jersey, Guernseys in Guernsey, Holsteins in Holland and all the leading breeds of cattle and sheep originating in Great Britain were each developed largely within one or more counties or shires, to the almost total exclusion of other breeds of the same species. Livingston county, Michigan, is known the country over for its Holstein cattle, the result of organization, co-operation and unity of purpose among its breeders.

One cannot conceive of any logical reasons why several men in a community could not form a co-partnership in the ownership and use of good sires. If such a plan could be followed, the good influences of superior sires would become more far reaching and fewer males in all would be needed than in the case of individual ownership. At present pedigreed males are usually introduced into communities by individuals. These men usually possess small herds and the one sire could be used upon a number of other herds, providing the neighboring owners could but see the advantage to be gained thereby. But, at present the man who introduces a good male and offers his services at a reasonable price, does not greatly benefit the community, as the prevailing practice is to patronize the sire offered at the smallest fee and this is always the grade or scrub. This form of co-operation is particularly suited to thickly settled communities where the farms and holdings of cattle are small, and consequently close together.

In general, it is the men with the smaller herds of cattle who resort most to mixed breeding and are in greatest need of good sires. We fully appreciate the fact that quite generally undesirable results have been derived from the formation of stock companies in the ownership of stallions. But it is our candid belief in this connection that most of the troubles among the stallion companies have arisen primarily through the fault of the organizer or promoter; the seller of stallions often unloads something on the company that does not prove satisfactory or that is not suited to the specific needs of the community and generally at prices amounting to double or treble the actual value of the animal.

ORGANIZATION OF CO-OPERATIVE BREEDERS' ASSOCIATION IN MICHIGAN.

In December, 1907, a recommendation was submitted to the Michigan State Board of Agriculture by the Agricultural Department of the college, urging the necessity for immediate action on the part of the college toward the development of co-operative organizations among the breeders and farmers of the state, designed to stimulate live stock improvement. This recommendation was accepted, adopted and the Agricultural Department authorized to undertake the work. W. F. Raven, of Brooklyn, Michigan, was appointed field agent to introduce, develop and promote the work and the details of the organization work have been very largely planned and put in operation by him.

Thus far the efforts have been confined solely to cattle and the first steps were taken among dairymen, as it was possible to reach this class easiest through creamery, condensary and cheese factory organizations and patron lists. The attention of the stockman and farmer was directed to the plan through the co-operation of the state press and the field agent has been working in those districts only in which his services were requested by the people. Before taking up the work in person in a given field, copies of the following introductory letter were sent to the patrons of the creamery or cheese factory or stockmen and farmers of the locality, viz.:

Dear Sir: The Agricultural Department of the Michigan Agricultural College has been authorized by the State Board of Agriculture to undertake special work in this state, endeavoring to stimulate the improvement of horses, cattle, sheep and swine. The proposed plan embodies a vigorous effort to induce farmers and stockmen to procure and use pure-bred sires rather than grades and scrubs. The plan is not only to advocate the individual ownership of good sires, as far as possible, but also to promote the establishment of associations for the joint ownership of males.

It will be the duty of the field agent in charge to present a practical method of live stock improvement to individuals and gatherings of farmers and breeders. As far as possible he will furnish information relative to the description, characteristics and adaptability of the various breeds. He will also lend assistance personally in the establishment of associations for the joint ownership of sires and the promotion of improved breeding. Through the agency of the State Live Stock Breeders' Associations, lists of breeders with pure-bred bulls for sale can also be furnished. If you are personally interested in live stock improvement and are willing to assist in interesting the people of your community, the services of the field agent can be secured without cost to you or the people you may succeed in interesting. Details of the work will be given upon request.

Yours very truly,
Field Agent in Charge.

The field agent calls upon the individual stock owner, looks over his animals, presents the co-operative plan to each man personally and secures data relative to the following direct questions, viz.: (1.) How many cows do you own? (2.) What breed or combination of breeds are they? (3.) What were they bred to last year? (4.) If you were to conclude to breed them to registered sires continuously, which breed would you prefer? Where the owners of eighty cows have signified a preference for some one breed the field agent then endeavors to induce the owners of forty more to adopt the same breed, thus securing sufficient for an association of three groups. The individuals are then invited to meet at some suitable place during an evening to discuss the proposition from every view point.

PLAN OF CO-OPERATIVE BULL ASSOCIATIONS.

When the owners of one hundred and twenty common cows decide upon some particular breed from which to select males for improvement, then an association may be formed. This particular form of organization containing one hundred and twenty cows is divided into three groups of forty cows each, with one bull for each group. There may be from two or three to seven or eight men in each group, depending on the size of the herds. Or there may be more groups in the association, depending on the willingness of the people of the community.

Each member joining an association is required to sign the following agreement, viz.: We, the undersigned, desiring to organize a bull association do hereby promise to pay equal sums of money on or before—— —————— for which we agree to take equal shares of stock in aforesaid association when organized. This association is organized for the purchase of three or more registered ———————— bulls, provided the groups of forty cows each can be secured. The understanding is that these bulls are to be owned in common and changed from group to group every two years, thus providing service for six years.

The field agent and the college aid only in procuring the sires by furnishing the members of the association with complete lists of all the known available bulls of the breed wanted, in the state. Failing to secure the desired animals from these lists, references to other reputable breeders are given. The associations must conduct their own financial transactions. In the case of the three group association at the end of two years to avoid in-and-in breeding, the bulls are changed from one group to another and the same thing done at the end of four years. In this way, barring accident or loss by death, the association is provided with registered males for a period of six years at an initial cost of from $10.00 to $40.00 per member. The owners within each forty cow group should be somewhat closely located, but this is not true of the groups, which may be several or more miles apart, their only concern being an occasional business meeting and the exchange of sires every two years. This plan has been carefully worked out and put in actual operation by Mr. Raven. All the associations now formed have incorporated under either Acts 171 or 243 of the laws of Michigan of 1903, with a view to holding the organizations together on a permanent basis. Copies of these acts with accompanying blanks may be secured by applying to the Secretary of State, Lansing, Mich.

ARTICLES OF AGREEMENT FOR ASSOCIATION. (INCORPORATED.)

Article 1.

It shall be the purpose of this association to procure and use pedigreed sires for the purpose of improving our live stock through a system of upgrading. This method of improvement implies the continued use of some one kind of pure blood on the grade and mixed bred stock. The association opposes the admixture of the blood of several breeds and the use of cross-bred grade and scrub sires. The association also pledges itself to exert every possible influence for the improvement and furtherance of the live stock interests of the community.

Article 2.

The name of this association shall be ——————————

Article 3.

The annual meetings of this association shall be held on the —————

Article 4.

The officers of this association shall consist of a board of five directors, from which shall be elected a president, vice-president, and a secretary-treasurer, whose term of office shall be one year, except the directors, whose term of office shall be three years. At the first meeting of this association there shall be elected one director to serve one year, two directors to serve two years, and two directors to serve three years.

Article 5.

The president shall preside at all meetings of the association and of the board of directors. He shall countersign all orders for money authorized by the association, or board of directors. He shall sign all stock certificates and have general supervision of the affairs of the association.

Article 6.

In the absence of the president, the vice-president shall have the same power and duties as the president.

Article 7.

The secretary shall keep a correct record of the proceedings of the association, also of the board of directors. He shall keep a debit and credit account of the financial transactions of this association. He shall furnish the caretakers of the sires of this association with books in which to record the service of each sire, together with the date of service, and the owner of the animal served.

He shall settle with the caretakers at least once in ——— months, giving them a receipt for all money received from them. At the annual meeting of the association each year, he shall give an itemized report of the business of the association for the past year; and at the expiration of his term of office shall turn over to his successor in office all books, papers and all property in his possession belonging to the association. He shall draw and sign all orders for money on the treasurer, authorized by the association or board of directors, also make out and sign all certificates of stock of the association.

As treasurer, he shall give a good and sufficient bond with at least two sureties for twice the amount of money that may come into his hands in any one year. He shall pay all orders for money drawn and signed by the secretary and countersigned by the president. When in funds, he shall keep a debit and credit account of all moneys received and paid out by him for the association. He shall at the annual meeting of this association give a report of amounts of money received and paid out by him, and settle with the board of directors by producing vouchers for all money paid out.

Article 8.

The regular meetings of the board of directors shall be on the ———

Article 9.

The board of directors shall have charge of all the business of the association, except in opposition of a majority vote of the stockholders of the association at regular or special meeting of the association.

Article 10.

Three directors shall constitute a quorum to do business, but a less number may adjourn to another date.

Article 11.

Special meetings of the association may be held on a call from the secretary, by notifying each stockholder at least twenty-four hours in advance of the meeting, also on petition of five stockholders to the secretary.

Article 12.

These articles of agreement may be amended at any meeting of the association by a majority vote of those present and voting.

BY-LAWS GOVERNING CO-OPERATIVE BREEDERS' ASSOCIATION.

(1.) It shall be the duty of the officers of this association to purchase the necessary sires and negotiate with competent parties within the association, centrally located, to care for and handle the bulls, at a sum not to exceed ———————— per annum.

(2.) All bulls must be purchased subject to the tuberculin test as a safeguard against the introduction of tuberculosis.

(3.) No bull, or bulls, or other breeding animals shall be purchased from any herd in which three or more cases of abortion have occurred during the past three years. (This will make reasonable allowance for accidental abortion and act as a safeguard against the ravages of contagious abortion.)

(4.) Should any contagious or infectious disease appear in the herd of any member of this association he must forfeit the right to patronize males of the association until such time as his herd is declared free from disease by a competent veterinarian.

(5.) A service fee of $1.00 shall be charged members of the association, to be collected at time of service. A charge of $2.00 will be made to non-members in case the association should decide to accept the patronage of the same.

(6.) Service fees shall be used to defray cost of maintenance and handling of sires. Any surplus accumulations from this source may be divided among stockholders as dividends.

(7.) It shall be the duty of the officers of this association to require and see to it that each sire is kept in a strong, vigorous, healthy condition, in moderate flesh, with plentiful supplies of suitable feed and sufficient yardage to afford ample exercise in the open air and sunshine in addition to the protection of the stable.

(8.) Bulls shall not be used for service under one year of age, nor shall heifers be bred to calve under twenty-four months of age. During the rush of the breeding season single services only will be allowed.

Mr. Raven, the field agent, began work about March 1st, 1908, and continued for two and one-half months, to which a similar amount of time was added during the autumn just passed. As a result, 569 herds have been visited, containing a total of 4,365 cows, of which 3.75 per cent were registered. Of the total number of these cows 15 per cent were bred to registered sires in 1907, but attention is directed to the fact that these were established dairy districts where continued effort has been made for some time to improve the live stock.

As a result of the five months' introductory work, ten co-operative associations have been formed and seven are in process of formation. In addition to this many who have not entered an association have been induced to procure registered sires. In all 51 registered sires are known to have been introduced and 2,100 cows which were bred to grade and scrub sires in 1907 will be bred to registered bulls in 1908 and 1909, as the result of five months' work of one field agent.

The incorporated association seems to give greatest promise of permanency, but is the most difficult to organize, owing to the difficulty in getting the members to decide upon one breed. Failing to organize one of these associations in a community we would prefer some other form of organization, rather than none at all. In some cases, as at Hudson, Michigan, a large number of breeders formed a somewhat different form of association, pledging themselves to use only Holstein sires, but each member will procure a bull. In other cases, as at Lawrence, Michigan, associations have been formed, the members of which have pledged themselves to use registered males only in all their breeding operations. Neither of the two last mentioned plans are apparently as binding or permanent as the first, and the last one is liable to lead to the use of a multiplicity of breeds or cross-breeding in a locality rather than the development of special features.

R. S. SHAW, Director.

W. F. RAVEN, Field Agent.

INOCULATION WITH NODULE-FORMING BACTERIA.

Circular No. 5.

EXPLANATION OF FIGURES:—Fig. 1. These two pea plants were grown in clean quartz sand to which had been added small quantities of all the necessary elements of plant food *except nitrogen.* The conditions were exactly identical except that plant A was without root nodudes (see Fig. 2) and plant B had numerous nodules well developed (see Figure 3.)

Failure to obtain a good stand of alfalfa, or any of the legumes, may be due to the following factors:

1. Poor seed.
2. Inadequate drainage.
3. Unsuitable soil.
4. Weed competition.
5. Absence of nodule-forming bacteria.

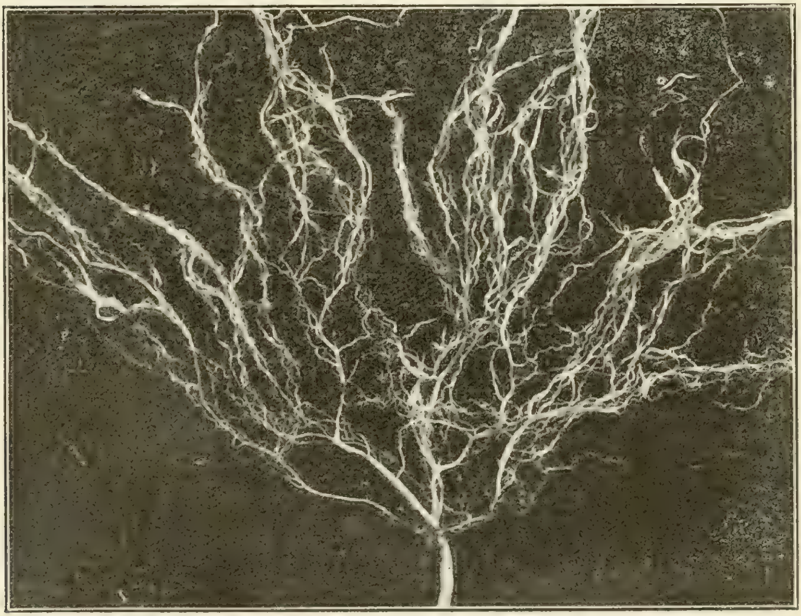

FIGURE 2.

The Value of Nodules.—

When the proper bacteria are present in the soil, some plants, such as alfalfa, clover, peas, beans, and other legumes develop nodules upon their roots in which these bacteria live in enormous numbers. In these nodules the free nitrogen of the air is so changed that these plants are able to make use of it in their growth. At the Illinois station, it was shown that 40 lbs. per acre of nitrogen might be added to a single cutting of alfalfa in this way, a gain of more than six dollars per acre. Beside this, a large amount of available nitrogen had been stored in the soil for the next crop. A crop of legumes *without nodules* would get all of its nitrogen from the soil as do the non-leguminous crops and would exhaust the soil of this element of fertility in the same manner.

There is *no reasonable* doubt as to the benefit to legumes of the proper nodule bacteria. Faulty methods of inoculation, however, have in the past given rise to much dissatisfaction and disappointment. Moreover, the condition of the soil may prevent nodular development, and the crop may fail even though proper inoculation methods have been employed.

Methods of Inoculation.—

Bacteria-laden soil, or soil taken from a field where a crop of the desired legumes has shown a good development of nodules, may be used to inoculate soil which does not contain these bacteria. The results obtained by this method have been almost uniformly satisfactory, though it is not entirely without objectionable features. Beside being somewhat cumbersome—from 100 to 500 lbs. of soil per acre are ordinarily used—there is always the possibility of introducing the seed of objectionable weeds or of spreading plant disease.

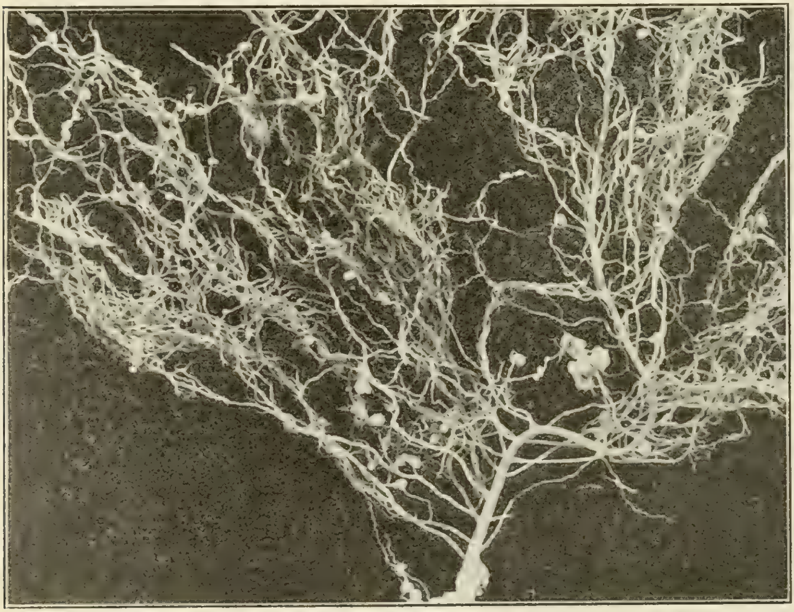

FIGURE 3.

Pure cultures of nodule bacteria suitable for the various legumes may be used in inoculating the seed just previous to sowing. This method has been used very extensively during the past three years, usually with marked success. In its favor may be mentioned, ease in shipment, assurance of a tested strain of bacteria, freedom from danger of spreading weeds or plant disease, and convenience in application.

The earlier history of the inoculation of seed by means of pure cultures is largely a record of failures, and seed inoculation, therefore, for a time, fell into general disrepute. No way had been discovered of keeping a sufficient number of bacteria alive and vigorous until the plant seedlings were ready for them. With the improvement of pure culture methods, seed inoculation now appears to be safe and advisable wherever satisfactory bacteria-laden soil may not be easily obtained.

The Need of Inoculation.—

Under favorable conditions, nodule bacteria may live in the soil for years. Therefore, it is seldom of advantage to inoculate for a leguminous crop which is being successfully grown in short rotations. However, it must be remembered that clover soil may need inoculating for alfalfa, or for peas, or for beans, and if the particular bacteria for any leguminous crop are not known to be present in sufficient numbers, it is advisable to insure their presence by proper inoculation. By inducing an earlier and more abundant development of nodules, inoculation may be profitable even in soils which contain the proper bacteria in limited numbers.

Inoculation will not be of benefit:—

(a) If the proper bacteria for the desired crop are already present in the soil in sufficient numbers.

(b) If the condition of the soil is such as to hinder the growth of either the plants or the bacteria.

Responsibility Assumed by the Experiment Station.—

Inoculation may or may not be of benefit to any leguminous crop according to conditions. So many other factors are involved that no guarantee of results can be made in any particular case. After four years of extensive field experiments with seed inoculation throughout the Provinces of Canada, the Ontario Station reports benefit resulting as follows: Alfalfa, 65% of all reports returned; clover, 56%; peas, 54%; beans, 54%. Seed inoculation in Virginia gave beneficial results in 82% of the cases reported.

In the soil inoculation experiments carried on in 33 of the counties of New York, satisfactory crops of alfalfa were obtained in 70% of the inoculated portions of the fields and in but 20% of the uninoculated portions of these same fields.

We have no means as yet of knowing just what results may be obtained in this state, but are in a position to coöperate with as many farmers as are willing to give the matter the attention required and to report results.

Prepared by
W. S. SAYER.

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FOREWORD.

The investigations of the keeping qualities of butter were begun only after much hesitation, lest they prove fruitless. However, after collecting the experiences of many cold storage men, learning of the difficulties encountered in handling butter made from collected cream, gaining some knowledge of the methods employed in the manufacture of butter, such as the incorporation of large amounts of starter in well washed butter, and listening to complaints from diverse sources as to butter purity, the problem appeared tempting, especially in the light of the paucity of systematic and fundamental knowledge available from the many sporadic research efforts touching this field of investigation. In order, therefore, to secure results which may be of the greatest utility to the farmer, the butter manufacturer, and the buyer who endeavors to hold butter in cold storage or otherwise for a rising market, only a systematic study, beginning at the very foundation, appeared seductive to the research man, and at the same time profitable to the men interested commercially. With this idea in mind the work for the past year has been conducted solely with an objective point to secure the proper basic data upon which to construct the specific investigations. This bulletin does not attempt to solve problems, but rather to furnish information for the specific problems which must be attacked before the question of the keeping qualities of butter may be understood satisfactorily.

The authors have striven to present the results of their work in such a form as to be most accessible, not only to themselves in their future researches, but to other investigators who may be wishing to take up similar problems.

CHARLES E. MARSHALL.

KEEPING QUALITIES OF BUTTER.

I.—GENERAL STUDIES

WILLIAM S. SAYER, OTTO RAHN, AND BELL FARRAND

Technical Bulletin No. 1.

INTRODUCTION.

Up to this time, very little reliable work has been done in this country in the way of demonstrating the nature of the microscopic life which is present in butter until it has become unusually rancid, and of showing the successive stages in the decompositions which render it unfit for use. In Europe, where most has been accomplished, the conditions are so radically different as to make much of the work done of scarcely any practical value to us. Little, if any, of the European work has had to do with actual cold storage, and we have found that the conditions obtaining at temperatures below zero centigrade, and those above the freezing point, are so far from parallel, and the changes which may take place so diverse, as not to allow of ready comparison.

In a work so extensive, it has not been the purpose to settle with any degree of finality any of the many questions with which we have been brought face to face. It is only by concentrated effort persistently directed against single, isolated problems, that such results are ordinarily obtained. There was need, however, for certain definite information, which could be obtained only by observing the changes which ordinarily take place in butter under conditions comparable with those of actual practice. Manifestly it is unfair to draw general conclusions from the results obtained from such extremely small samples as have sometimes been used.

Although the supply of butter is fairly constant and much more nearly meets the demand than is the case with many other foods, still there are times, as in May, June and perhaps July, when there is an excessive supply which may be stored to profit for the scarcity of the late winter, provided that it is of good quality when removed, and therefore salable at that time. It is, of course, not to be expected that a butter which has been kept for some weeks or months will retain all the delicate aroma of a perfectly fresh butter made according to the best known methods. Some butters do, however, come out of storage, after several months, with a better flavor than other perfectly fresh butters, which have not been so carefully made. Certain butters may even come out of storage better than when placed in. Again, two lots, when received may score alike, and, though kept under conditions identical, one lot may come out in excellent condition while the other may have deteriorated to such an extent as to render it utterly unsalable. The purpose of this work is simply to give a general view of the changes in cold storage butter and to break up the whole question of the cold storing of butter into single problems which may afterward be worked out separately.

PREVIOUS WORK.

The two most vitally important questions concerning the rancidity of butter are: first, What compounds cause the rancid taste and smell? and second, How are they produced in butter? The first question is not yet satisfactorily answered, and therefore, of course, the second cannot be answered completely.

The original idea, the simplest, was that in some way the fat was split into glycerine and free acids and that these, especially the butyric and capronic acids, cause the rancid taste. The observation that butter protected from air kept better, led to the theory that oxidation, also, must have something to do with rancidity. With this latter thought Schmidt and Schaffer attempted to correlate the progress of rancidity and the increase in aldehyde, but found them apparently unrelated. Amthor considered ethyl butyrate a factor concerned with the rancid smell and odor. This, he thought, was produced by a reaction of butyric acid with the alcohol produced from fermentation of the lactose.

Jensen notes that the volatile saponifiable substances in rancid butter arise not alone from the esters of the volatile fatty acids, as shown by the difficult saponifiability of a part of them, and the fact that the amount of these substances is not always in proportion to the rancidity of the butter. It is clear that the palatability of a fat does not necessarily depend upon the content of free fatty acid, since only these acids or esters which are volatile, or soluble in water, affect the sense of taste. Reinmann (l. c., p. 212) noticed in one sample a rise of 19.5 degrees of acidity without any rancidity, while another sample became very rancid with an increase of only 10.0 degrees. Therefore, the more or less strong odor of ester which a butter develops is not always in proportion to the determined amount of volatile, saponifiable substances.

Duclaux showed that aroma and color were destroyed by contact with the air in the presence of light, and that the butter became tallowy and white. He hastened this reaction by absorbing the butter by means of pumice stone, and determined the absorption of oxygen and formation of CO_2. This oxidation of the butter caused a distinct increase in its weight, which was considerably higher in the case of olein and oleic acid than of butter fat, as would be expected.

Ritsert isolated various micro-organisms, chiefly yeasts and oidium molds from old, rancid fat, and inoculated these into fresh, undecomposed fat, in order to determine if they might render this rancid also, but found that the micro-organisms would not develop in the fresh fat, and therefore could not cause rancidity. It is for this reason that perfectly pure lard or tallow may be kept for so long in a fresh condition if protected from light.

Jensen placed samples of butter in glass tubes which, both unsterilized and sterile, he exposed to sunlight, diffused light, and darkness, at temperatures of 35° and 20°C. After periods of from one to ten weeks he determined the amount and nature of the changes effected by means of the senses of taste and smell, the rise in acidity or aldehyde and the decrease in the iodine number. He also counted the organisms present. The results of this work may be summed up as follows:

After a week the taste of the butter exposed to sunlight was so bad that it was difficult to determine whether it was worse at the end of three weeks. It gave at three weeks a strong aldehyde reaction. The butter kept in the incubator in diffused light did not taste as bad as that in sunlight. The acidity of the incubator butter was higher than that kept in sunlight, but this was due, largely, to lactic acid rather than a hydrolytic decomposition of the butter fat. In the sunlight, as well as in the incubator, the butter melted, the butter-milk and other nutrient matter settled to the bottom and the clear fat on top became almost sterile. The acidity of the butter kept at room temperature (not melted) was higher than either. At the end of the experiment the acidity of the butter kept in the dark at room temperature was the highest, that in sunlight the lowest.

It follows, he says, that oxygen does not play the direct rôle in the oxidation. The portion kept in darkness at room temperature was especially rancid. It is shown that:

(a) Acid number is highest where germ number is highest.

(b) Other things being equal, sterile butter is more oxidized than non-sterile.

Since on the one hand micro-organisms increase the rancidity of butter, and on the other hand, protect it from oxidation, the conditions for rancidity of butter stand in opposition to those of oxidation, which further emphasizes the fact that *oxygen cannot be the direct cause of rancidity in butter.* The rôle of oxygen can, therefore, only be to favor the development of the organisms necessary for this process. The changes which ordinary butter at an ordinary temperature undergoes are of an entirely different nature from those caused by sunlight. The free fatty acids in ordinary rancid butter are for the most part non-volatile; that decomposed by sunlight, volatile.

His conclusions are:

"(a) The air plays a direct rôle in the decomposition of butter only when it is exposed to the sunlight, or to a high temperature. The butter is then *oxidized* and acquires on this account a very disagreeable smell and taste—but does *not* become rancid.

(b) Butter becomes rancid only by the action of certain micro-organisms. Since all of these require air, the rancidity proceeds from the surface to the interior, as does the ripening of soft cheese.

(c) The micro-organisms which, under ordinary circumstances, cause rancidity in butter are:

Oidium lactis,
Cladosporium butyrii,
B. fluorescens liq.,
B. prodigiosus (occasionally).

All of these split butter fat. The volatile fatty acids are formed at first by the bacteria, and later by the associative action of the two molds. From this associative action also arises the butyric ester.

(d) The use of salt diminishes the production of volatile fatty acids; and lactose, the production of esters. Whether the combined action of the two can completely prevent rancidity is yet to be determined.

(e) On account of the frequent occurrence of B. fluorescens liq., and B. prodigiosus in water, it is to be supposed that they gain entrance to the butter from the wash water. Since B. fluorescens is much more frequent in water than B. prodigiosus it is also found much more frequently in butter.

(f) As to Oidium lactis and Cladosporium butyrii they come, without doubt, from the air, as is the case with other mold contaminations. In the air of dairies, Oidium lactis is commonly very abundant."

At the Ontario Agricultural Experiment Station, and in the Dairy Division of the New Zealand Department of Agriculture, opportunity has been given for observing, in a superficial way, the changes which take place in butter sent in refrigeration to the English markets. Gray studied the problems of pasteurizing, salting and packing, experimentally.

Pennington studied the effect of low temperature upon the development of the micro-organisms present in milk, and found an enormous increase even when the milk was kept at a temperature below the freezing point, so that it became partially congealed.

Rogers excluded air from the butter in tubs by coating the tubs with paraffin. This prevented the growth of molds and favored the keeping of the butter.

From these investigations and others, cited in Lafar's *Handbuch der Technischen Mykologie*, II, pp. 210, (H. Weigmann), Reinmann, *Untersuchungen ueber die Ursachen des Ranzigwerdens der Butter,* and by Otto Rahn, *Die Zersetzung der Fette,* we may draw the following conclusions:

The term "rancid" is not definitely fixed. Very probably we have different chemical compounds in different rancid butters. Free butyric acid certainly causes a rancid taste in butter, but its amount is not always high enough to cause an off flavor. The same is true of ethyl butyrate. The decomposition of the unsaturated oleic acid is due to oxidation brought about more by the action of light than by organisms and causes not so much a rancid as a tallowy taste. The rancidity of butter is almost certainly due to micro-organisms, some of which effect a hydrolytic decomposition of the glycerides of the saturated fatty acids, for butter sterilized by heat keeps indefinitely if kept from micro-organisms, light and air. It cannot be due to a fat splitting enzyme originally present in the milk because if so, the butter from pasteurized or sterilized cream should keep, whereas it spoils in the same way as ordinary butter, though usually much more slowly. However, most of the bacteria found in butter do not seem to have any relation to rancidity, though some of them do cause an alteration in the taste. From the investigations of Hanus and Stocky we know that several molds, especially Penicillium glaucum, Aspergillus, and also Mucor, decompose fat into free acids and might cause a rancid taste in this way.

All investigations show that the spoiling of butter is an aerobic process, beginning at the surface and slowly penetrating through the whole butter. A number of instances are on record of the finding of butter which had evidently been buried in bog water for centuries, in one case a sample of about 20 pounds having been submitted to the ordinary chemical determinations after its recovery. That under these conditions decomposition would take place very slowly indeed, is not surprising, since these fatty acids consisting of long chains of CH_2 groups and only two oxygen atoms, are very difficultly decomposed by any anærobic process. The glycerine may, of course, be decomposed anærobically, but this constitutes only about five per cent of the total fat.

These results refer to butter kept at ordinary temperature, and would naturally differ from those obtained in cold storage.

OUTLINE OF THE WORK.

Samples were obtained during May and early June by different members of the bacteriological staff who personally observed the methods of manufacture, creamery conditions, surroundings and everything which might affect the finished product—temperature of cream and wash-water used, source of the water and ice, methods of obtaining and handling cream, personality of butter-maker, etc. Tub lots were secured from as many creameries as possible in the dairy sections of the state—seven 60 lb. tubs being ordinarily taken from a single churning at each place visited. These tubs were immediately tagged and shipped at once by express to the laboratory.

The Score.—Immediately upon receipt of the butter at the laboratory cold storage, the samples were scored by a dairy expert. Particular attention was given to flavor, texture, moisture and salt. The butter was subsequently scored from time to time as mentioned later.

Laboratory Samples.—Samples were obtained with the ordinary precautions, in most cases just previous to scoring, in order to lessen the possibility of accidental contamination.

Storage.—After the laboratory sample had been taken and the butter had been scored, each sample lot was divided as follows: the broken tub was kept at the station cold storage at the temperature of 38°–42° F. (5°C.); of the six remaining tubs, two were shipped to each of three different cold storage plants, subject to withdrawal as required for sampling.

About the first of November, one tub from each lot was scored at the storage warehouse where it had been kept, after which the scored tubs were brought to the local cold storage and sampled for the laboratory as required. At this time seventy-two tubs were examined at the rate of four a day.

As soon as the samples had all been obtained, the sampled tubs were set out without regard to order or place of storage and scored again by a second expert butter scorer, the tubs being known by number only—Arabic 1–126. These tubs were then disposed of, the duplicate samples being retained in the various places of cold storage for the later examination.

On the first of February the remaining tubs of butter were withdrawn from storage and examined as before. As the ordinary temperature was low at this time, the tubs were all assembled at the college cold storage for sampling and scoring.

Disposal of butter.—Since the sale of the butter used in these tests may be of interest, it is given here. The first lot was sent to New York in February and was priced as follows: One tub at 27c; six tubs at 25c; twenty-three tubs at 23c; thirteen tubs at 19c.

Of the second lot, that sent to New York arrived on a dull market and was sold in one lot, fifty-three tubs at 18c, which was one-half cent less per pound than ten tubs bought at a renovating establishment at this time, although this latter lot was withheld from shipment as being much inferior to the other. The average score for February was two and one-quarter points lower than in November, the two scores being 89½ and 87¼, respectively.

METHODS.

Obtaining Samples.—Samples of butter were taken from tubs with sterile triers and placed in sterile one pint Mason jars. A separate sterile butter trier and short cheese trier were used for each sample, and about two inches from top and bottom discarded. These samples (about ½ pint each) were melted in a water bath at 35° C., partially cooled, vigorously shaken to insure uniformity, and the samples required for bacterial and chemical determinations poured into the appropriate dishes.

Bacterial Content and Isolation.—A small amount of butter, about 25 cc., having been poured from the Mason jar into a 60 cc. Erlenmeyer flask, this, together with the dilution flasks containing 99 cc. each of sterile 0.6% salt solution, was kept in a water bath at 35° C. Pipettes sterilized in plugged test tubes were kept in a water bath at 50° C. After shaking the butter sample well, 1.15 cc. (= 1 gram) were measured from a warmed sterile pipette into 99 cc. of salt solution. This was shaken well to a milky emulsion and other dilutions similarly made by introducing 1 cc. of the dilution already prepared into 99 cc. of sterile salt solution. Dilutions of 1-1000, 1-10,000, and 1-100,000 were then plated in ordinary agar, whey agar, whey gelatin and litmus glucose agar. In the November and February examinations, dilutions of 1-100, 1-1,000 and 1-10,000 were employed.

Ordinary agar was made according to the rules adopted by the Committee on Standard Methods (Jour. Inf. Dis., Suppl. No. 1, 1905.) It was adjusted to 15°.

Whey agar was made as follows: Fresh skimmed milk at 41° C., was loppered by adding sufficient rennet (about ½% liquid rennet in 20 cc. of distilled water). After the curd was firm it was cut in fine pieces and placed in steam for 40 minutes. It was then strained through muslin to remove curd. The reaction of the whey was adjusted to 15° acid with standard NaOH, and 1% of dry peptone and 1.5% finely shredded agar added. It was then placed in the steam for one hour. The reaction was readjusted to 15° acid, cooled to 60° C., clarified with egg albumen, counterpoised, boiled over free flame for five minutes, loss made up with distilled water, filtered through a hot washed plaited paper filter, tubed and sterilized 15 minutes in steam for three consecutive days.

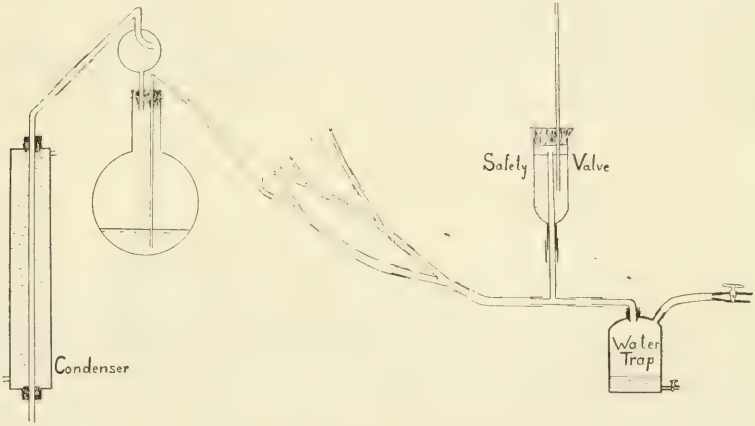
The ordinary and whey agar plates were kept at 20–22° C., and counted at the end of seven days, descriptions and numbers of each type of colony being noted. Typical colonies from each plate were isolated into bouillon, incubated two days at 20°–22° C., replated in gelatin and fished as pure cultures to slant agar tubes. Each culture was then sub-cultured to bouillon, gelatin, milk (20 and 37° C.), potato, Dunham's broth for indol, and the three sugar broths in fermentation tubes.

Whey gelatin was prepared according to the method of Conn (Bacteria in Milk and its Products, 1903, p. 270). Plates were kept in cold storage at about 4° C. for 30 days undisturbed, when they were counted and cultures isolated as in the case of agar plates.

Litmus glucose agar plates were placed in Novy jars and kept in hydrogen gas at 20–22° C. for the development of anærobes. After 7–10 days the jars were opened, the different typical colonies from each plate described and picked up in 2% glucose broth tubes and incubated in hydrogen in Novy jars. After a few days plates were made, using litmus glucose agar and incubating in Novy jars. From these plates duplicate inoculations were made on slant agar tubes, one tube of each being kept under ordinary conditions while the other was kept in hydrogen gas.

The November and February samples were plated in standard agar only, and after isolation were run in bouillon, gelatin, milk, and the three sugars, dextrose, lactose and saccharose in fermentation tubes. In the February examination only those organisms not typically lactic were isolated.

Moisture.—About 5 grams of the sample were poured in duplicate into small, flat-bottomed, weighed, porcelain evaporating dishes of 65 mm. diameter, containing short stirring rods. These were weighed, dried at 100–105° C. in the electric drying oven for three hours, weighed, dried for another hour, and weighed again. The total loss in weight was computed as percentage of moisture.



Salt and Curd.—To the melted dried butter in the evaporating dishes, ether was added from a wash bottle and stirred well by means of the stirring rods, then decanted through weighed, 9 cm. filters. Several small portions of ether solution were thus decanted through the filters, after which the salt, curd, etc., remaining in the evaporating dishes was washed onto the filters with the aid of the ether wash bottle. The filters were put back into the weighing bottles, dried for a half hour at 100° and weighed for total solids not fat.

The dried filters were then put into funnels and thoroughly washed with hot water. The amount of salt in the filtrate was determined by means of standard $AgNO_3$. The difference between this and the total solids not fat was reported as curd.

Butter Fat.—The difference between the total solids and the total solids not fat constituted the ether extract and was reported as fat.

The Rancidity (*Acidity*) tests were made as follows: Samples of about 5 grams were accurately weighed in 60 cc. Erlenmeyer flasks, melted, 10 cc. of ether (1-10% phenolphthalein in ether) added and titrated with alcoholic potash. The strength of the alcoholic potash does not remain constant and is determined each time with $^N/_{10}$ HCl. The results are reported in terms of cc. of $^N/_1$ acid per 100 grams of butter.

Reinmann (l. c., p. 139) dissolved the butter in 25 cc. of alcohol and ether in equal parts and then titrated with $^{N}/_{10}$ NaOH. This obviates the necessity of using the somewhat unstable alcoholic potash.

Determinations of *the volatile acids and esters* in the college storage butter were made in November, employing the method of Amthor as described by Jensen. In the distillation the high pressure steam of the laboratory was used, passing this through a water trap to remove water, iron rust, oil, etc. A safety valve was introduced as shown in the illustration to prevent the contents of the flasks from being sucked back. A copper one-gallon can was used for the water trap. A carbon funnel, with stoppers, tubes, and water as shown constituted the safety valve.

After passing the trap the steam was led to the bottoms of the flasks containing 10 grams of butter. The condensed steam with the volatile acids was allowed to run into 500 cc. flasks until they were filled up to the mark, and this titrated against $^{N}/_{10}$ NaOH using phenolphthalein as indicator. The condensers were rinsed with 100 cc. of 30% neutral alcohol. After the volatile acids had been thus determined, the neutral liquid was mixed with 50 cc. of $^{N}/_{10}$ NaOH and boiled for about half an hour with a reflux condenser. After cooling it was titrated with $^{N}/_{10}$ HCl. It was necessary to make a correction for the esters which the alcohol contained.

HISTORY OF THE BUTTER SAMPLES.

The history of butter samples is divided into several parts, the general creamery conditions, the churning conditions, the shipping and storing and finally the sampling.

The creamery and churning conditions are given in the following two tables —I and II—in order to allow easy comparison. The creamery which furnished the butter lot XI was not visited. As to the churning conditions, a few notes must be added, which did not fit into the tables.

TABLE I.

Creamery Conditions.

Place.	Sanitary Condition.	Character of Building	Condition of Rooms.	Cleanliness of Rooms.	Person of Butterm'kr	Condition of Utensils.	Care in Man'gem't.	Water Supply.	Sewage Disposal.
II	Good	Fair	Good	Fair	Fair	Fair	Fair	Question'ble	Good
IV	Medium	Good	"	Good	Good	Good	Good	"	Poor
VI	Good	New	"	"	"	Fair	"	Good	Good
VIII	"	Fair	Fair	Fair	Fair	"	"	"	"
X	Good	Good	Good	Good	Good	Good	Good	"	"
XI	....	New	....	....	....	....	....	....	....
XIII	Poor	Frame	Bad	Dirty	Fair	Fair	Bad	Well	Bad
XIV	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Good
XV	Fair	Good	"	"	Poor	"	"	Question'ble	Good
XVI	Good	"	Good	Good	Good	Good	"	Good	"
XVII	"	"	"	"	"	"	"	"	"
XVIII	"	"	"	Fair	"	"	"	"	"
XIX	"	Poor	Fair	Good	Fair	"	"	"	"
XX	"	Good	Good	"	Good	"	"	"	"
XXI	Bad	Bad	Very bad	Very bad	Very bad	Bad	Bad	"	"
XXII	Good	Good	Good	Good	Good	Good	Good	Question'ble	"

TABLE II.

Churning Conditions.

Sample.	Cream.						Churning.		Temp. of Water.
	Source.	Pasteurized.	Kind of Starter.	Amt. Starter.	Time Ripened.	Acidity.	Time.	Temp.	
II	½ gathered, ½ whole milk	No	None	None	....	....	45 min.	50° F	52° F
IV	Combined	"	Natural	10%	7 hrs.	.65%	35 min.	54°	64°
VI	½ gathered, ½ whole milk	"	Hansen's	8%	4 "	.68%	40 "	55°	56°
VIII	Gathered	180°	Commercial	10%	24 "	.60%	45 "	55°	52°
X	"	175°	Erickson	20%	24 "	.60%	40 "	52°	59°
XI	"	Yes	Natural	10%	24 "	....	....	....	......
XIII	"	No	None	None	....	....	....	....	......
XIV	"	"	P. D. & Co.	10%	12 hrs.	.42%	45 min.	54°	62°
XV	Whole milk	"	Douglas	8%	12 "	.55%	1 hr.	55°	......
XVI	" "	"	P. D. & Co.	12%	5 "	.53%	45 min.	52°	......
XVII	" "	"	Douglas	15%	18 "	.55%	45 "	54°	......
XVIII	" "	"	Natural	10%	24 "	....	1 hr.	52°	......
XIX	" "	"	"	6%	18 "	....	40 min.	52°	54°
XX	" "	"	Hansen	5%	18 "	....	30 "	58°	52°
XXI	½ gathered, ½ whole milk	Yes	None	None	48 "	....	45 "	60°	56°
XXII	Whole milk	No	None	None	24 "	....	30 "	55°	......

II. Creamery very small. 250 lbs. of butter churned three times a week. Butter the size of wheat grains. Washed twice and worked twice in the churn.

IV. Most of the cream separated from the whole milk. Butter grains the size of peas, washed once and then churned 2 to 3 minutes with churn filled ⅔-full of water. Worked twice.

VI. With butter the size of wheat grains, the buttermilk was drained off, the butter washed once and then churned for 2–3 minutes in ⅔ of a churn full of fresh water. Worked three times.

VIII. Butter the size of wheat grains, washed once and worked once.

X. Cream old and overheated. Butter washed once and worked three times.

XIV. Butter churned to size of walnuts, washed once and worked three times.

Samples II, IV and VI were obtained from small creameries and it was not possible at the date of the visits to obtain seven tubs from the single churning. The deficiency was made up from butter churned just previously as indicated. Inasmuch as the general conditions were the same for all, the seven tubs were run as a single lot in each case.

The history of shipping, storing and sampling is a very extensive one, since each tub has its own history different from all others. The principle of the experiment was to bring the tubs as soon as possible after churning to the storages and to the laboratory. The samples were bought in May and June, except the lots I, III, V, which were made and investigated in February. There was sometimes some delay in shipping or storing, especially in the cold storage *d*, which was not at first prepared for our samples. In November, the tubs *c* and *d* were shipped to storage *b* and sampled and scored there. In the case of lot XVIII, four tubs only were secured and these were sampled after six and nine months. Samples XVIII*c* and XVIII*d* were obtained from the tubs in the storage warehouses and brought at once to the laboratory where they were plated the next day. As the samples were kept cold, no great change could have taken place. In February all samples were taken to the station storage, which was cold enough at that time to keep the butter.

TABLE III.

History of the Butter Samples.

Number.	Churned.	Arrived at Station.	Sampled.	Scored.	Placed in Storage.	Removed from Storage.	Sampled.
I a	2-6-07	2-6-07	2-8-07	2-8-07	....	....	10-28-07 2-3-08
b	"	"	....	....	2-12-07	2-7-08	11-4-07 2-8-08
III a	"	"	2-8-07	2-8-07	....	....	10-28-07 2-3-08
b	"	"	....	....	2-12-07	2-7-08	11-4-07 2-8-08
V a	2-7-07	2-7-07	2-8-07	2-8-07	....	....	10-28-07 2-4-08
b	"	"	....	....	2-12-07	2-7-08	11-4-07 2-8-08
IX a	Renovated.	5-22-07	5-22-07	5-23-07	....	....	10-29-07 2-4-08
b	"	"	....	....	6-10-07	....	11-5-07
c	"	"	....	....	"	11-15-07	11-19-07
d	"	"	....	....	6-17-07	11-8-07	11-12-07
e	"	"	....	....	6-10-07	2-7-08	2-14-08
f	"	"	....	....	"	2-6-08	"
g	"	"	....	....	6-17-07	"	"
II a	5-10-07	5-11-07	5-13-07	5-14-07	....	....	10-28-07 2-3-08
b	"	"	....	....	5-14-07	....	11-4-07
c	"	"	....	....	6-10-07	11-15-07	11-18-07
d	5-6 or 8-07	"	....	....	6-17-07	11-8-07	11-11-07
e	"	"	....	....	5-14-07	2-7-08	2-10-08
f	"	"	....	....	6-10-07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
IV a	5-11-07	5-11-07	5-13-07	5-14-07	....	....	10-29-07 2-3-08
b	"	"	....	....	5-14-07	....	11-5-07
c	"	"	....	....	6-10-07	11-15-07	11-18-07
d	"	"	....	....	6-17-07	11-8-07	11-11-07
e	"	"	....	....	5-14-07	2-7-08	2-11-08
f	5-9-07	"	....	....	6-10-07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
VI a	5-11-07	5-13-07	5-13-07	5-14-07	....	....	10-29-07 2-4-08
b	"	"	....	....	5-14-07	....	11-5-07
c	"	"	....	....	6-10-07	11-15-07	11-18-07
d	5-9-07	"	....	....	6-17-07	11-8-07	11-11-07
e	5-11-07	"	....	....	5-14-07	2-7-08	2-12-08
f	5-9-07	"	....	....	6-10-07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
VIII a	5-20-07	5-22-07	5-22-07	5-23-07	....	....	10-29-07 2-4-08
b	"	"	....	....	6-10-07	....	11-5-07
c	"	"	....	....	6-10-07	11-15-07	11-18-07
d	"	"	....	....	6-17-07	11-8-07	11-11-07
e	"	"	....	....	6-10-07	2-7-08	2-13-08
f	"	"	....	....	6-10-07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
X a	5-17-07	5-18-07	5-20-07	5-23-07	....	....	10-30-07 2-5-08
b	"	"	....	....	6-10-07	....	11-6-07
c	"	"	....	....	6-10-07	11-15-07	11-19-07
d	"	"	....	....	6-17-07	11-8-07	11-12-07
e	"	"	....	....	6-10-07	2-7-08	2-17-08
f	"	"	....	....	"	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XI a	5-18-07	5-20-07	5-20-07	5-23-07	....	....	10-30-07 2-5-08
b	"	"	....	....	6-10-07	....	11-6-07
c	"	"	....	....	"	11-15-07	11-19-07
d	"	"	....	....	6-17-07	11-8-07	11-12-06
e	"	"	....	....	6-10-07	2-7-08	2-17-08
f	"	"	....	....	"	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XIII a	....	6-3-07	6-6-07	6-7-07	....	....	10-30-07 2-5-08
b	....	"	....	....	6-10-07	....	11-6-07
c	....	"	....	....	"	11-15-07	11-19-07
d	....	"	....	....	6-17-07	11-8-07	11-12-07
e	....	"	....	....	6-10-07	2-7-08	2-19-08
f	....	"	....	....	"	2-6-08	"
g	....	"	....	....	6-17-07	"	"

TABLE III.—Concluded.

History of the Butter Samples.

Number.	Churned.	Arrived at Station.	Sampled.	Scored.	Placed in Storage.	Removed from Storage.	Sampled.
XIV a	5 21 07	5-24-07	5 24-07	6-7 07	....	....	10-30-07 2-5-08
b	"	"	....	....	6-10 07	....	11-6-07
c	"	"	....	....	"	11-15-07	11-20-07
d	"	"	....	....	6-17-07	11-8-07	11-13-07
e	"	"	....	....	6-10-07	2-7 08	2-20-08
f	"	"	....	....	"	2 6 08	"
g	"	"	....	....	6-17-07	"	"
XV a	6 6-07	6-7-07	6-7-07	6-11 07	....	....	10-31-07 2-6-08
b	"	"	....	....	6-10-07	....	11 7-07
c	"	"	....	....	"	11-15 07	11-20-07
d	"	"	....	....	6-17-07	11-8-07	11-13-07
e	"	"	....	....	6-10 07	2 7-08	2 21-08
f	"	"	....	....	"	2 6 08	"
g	"	"	....	....	6-17 07	"	"
XVI a	6-5 07	6-7-07	6-7-07	6-11 07	....	....	10-31-07 2-6-08
b	"	"	....	....	6-10-07	....	11-7-07
c	"	"	....	....	"	11-15 07	11-20-07
d	"	"	....	....	6-17-07	11-8 07	11-13-07
e	"	"	....	....	6-10 07	2-7 08	2-24-08
f	"	"	....	....	"	2-6 08	"
g	"	"	....	....	6-17-07	"	"
XVII a	6-6-07	6-8-07	6-9-07	6-11-07	....	....	10-31-07 2-6-08
b	"	"	....	....	6-10-07	....	11-7-07
c	"	"	....	....	"	11-15 07	11-20-07
d	"	"	....	....	6-17-07	11-8 07	11-13 07
e	"	"	....	....	6-10-07	2-7-08	2-25-08
f	"	"	....	....	"	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XVIII a	6-6-07	6-8-07	6-9-07	6-11-07	....	....	10 31-07 2-6-08
b	"	"	....	....	6-10 07	2-7-08	11-7-07 2-26 08
c	"	"	....	....	"	2-6 08	11-8-07 2-26-08
d	"	"	....	....	6-17-07	"	11-8 07 2 26-08
XIX a	6-6-07	6-8-07	6-9-07	6-11-07	....	....	11-1-07 2-7-08
b	"	"	....	....	6-10-07	....	11-8-07
c	"	"	....	....	"	11-15 07	11-22-07
d	"	"	....	....	6-17 07	11-8-07	11-14-07
e	"	"	....	....	6-10 07	2-7-08	2-27-08
f	"	"	....	....	"	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XX a	6-7-07	6-10-07	6-10 07	6-11 07	....	....	11-1-07 2-7-08
b	"	"	....	....	6-17 07	....	11-8-07
c	"	"	....	....	6-24-07	11-15-07	11-22-07
d	"	"	....	....	6-17-07	11-8-07	11-14-07
e	"	"	....	....	6-17-07	2-7-08	2-28-08
f	"	"	....	....	6-24 07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XXI a	6-7-07	6-11-07	6-12 07	6-12 07	....	....	11-1 07 2-7-08
b	"	"	....	....	6-17-07	....	11-8-07
c	"	"	....	....	6-24 07	11-15 07	11-22 07
d	"	"	....	....	6-17-07	11 8 07	11-14-07
e	"	"	....	....	6-17-07	2-7-08	3 2-08
f	"	"	....	....	6-24 07	2-6-08	"
g	"	"	....	....	6-17-07	"	"
XXII a	6-6-07	6-12-07	6-13-07	6-13 07	....	....	11-1-07 2-7-08
b	"	"	....	....	6-17-07	....	11-8-07
c	"	"	....	....	6-24 07	11-15-07	11-22-07
d	"	"	....	....	6-17-07	11-8-07	11-14-07
e	"	"	....	....	6-17-07	2-7-08	3-3-08
f	"	"	....	....	6-24-07	2-6-08	"
g	"	"	....	....	6-17-07	"	"

Little irregularities, delays in shipping and special details may be looked up in Table III.

Lot IX was renovated butter, which was bought in May. We know nothing about the way it was manufactured.

In the following discussions of experiments, lots I, III, V, and IX are always separated from the other 16 regular lots, because I, III and V were 3 months older than the rest and were represented only in the *b* storage, and the renovated butter could not be compared with fresh butter. These four lots are also excluded from all averages.

Storages.—Storage *a* was the Station fruit storage, which had an average temperature of about +5° C. The tubs I*a*–VI*a* were kept at +20° C. in one of the constant temperature rooms of the laboratory until after the November examination, when they were brought to the station storage and kept there until February.

Storage *b* was cooled by an ice and brine gravity system and was kept at about —7° C. (20° F.). Though not so well cooled as was the case with *c*, the butter room was clean and the management good.

Storage *c*, the best, was a mechanical refrigerating plant which left little to be desired in the way of cleanliness and general management. The butter room was kept at a temperature of —10° C.

Storage *d* was mechanically cooled and held at about —5° C. All sorts of produce were thrown into the rooms together and the cleanliness did not accord with accepted notions. In the February examination the storages *b*, *c* and *d* correspond to *e*, *f*, *g*.

Dates of Scoring.—In November Mr. Foster scored the butter of series *b* on the 2d, series *a* on the 5th, series *c* and *d* on the 8th. Mr. Rabild scored all on the 26th. In February Mr. Foster's scores were made on the 9th and Mr. Rabild's on the 18th.

THE BUTTER SCORES.

Table IV gives a detailed summary of the scores of all samples of butter examined. As previously stated, each lot consisted of seven tubs, taken from a single churning, except as noted. Tub *a* of each lot was scored immediately on its arrival at the station, as noted in Table III. Tubs *b*, *c* and *d* were scored in the various cold storage warehouses in November, and the corresponding tubs *e*, *f* and *g* were scored in February.

The fresh butter was scored by Mr. F. O. Foster, now Inspector, Michigan Dairy and Food Department, who also made the scores which appear first for the stored samples. All stored butter was again scored by Mr. Helmer Rabild, now expert in Dairying, Dairy Division, Bureau of Animal Industry, U. S. Department of Agriculture.

COMPARISON OF THE TWO SCORINGS.

That Mr. Foster's experience up to this time had been almost exclusively with strictly fresh butter accounts in large measure for the unusually low scores which he gave to most butters which had off flavors. Considering the extreme difficulty of assigning a definite numerical value to each of the many off flavors which are found in stored butters, the relative scores check fairly well.

TABLE IV.

The Butter Scores.

Number.	Flavor.									Loose Moisture.		Salt.		Notes.	Score.
	Light.	Flat.	Curdy.	Rancid.	Fishy.	Unclean.	Aged.	Tallowy.	Metallic.	Too much.	Cloudy.	Too much.	Too little.		
I a							+								92
b	+	+													90
				±											92
c				±											88
			+	±											91
III a							+								91
b				+											75
				+											89
c				+											84
			+	+		+									86
V a							+							Bitter, undissolved salt	90
b				+											83
				±											91
c				+				+							83
			+										+		91
IX a				+							+			Mealy, oily, short grain	83
b							+	+							85
			+				+							Salvy	89
c						+					+				85
														Short grain, oily	91
d				+				+							82
					±									Short grain, pasty	88
e						+								Mealy	82
							+							Mealy	89
f						+									84
							+							Old cream, oily, doughy	87
g						+									87
					±				+					Mealy	85
II a	+														96
b				+											83
	+			+											90
c				±				+					+		85
				+		+							+		90
d				+											80
				++											86
e				+										Too high color	86
				+											89
f				+										Color wavy	85
				++											87
g				+											85
				±										Cheesy, moldy, mottles	87
IV a							+					+			91
b				+											87
							+								90
c														High acid	89
															91
d							+								88
							+								92
e				±								+			87
				±	±				+			+			87
f						+									80
							+							Old cream	90
g						+								Sour	86
							+							Old cream, off salt	90

TABLE IV.—Continued.

The Butter Scores.

Number.	Flavor.									Loose Moisture.		Salt.		Notes.	Score.
	Light.	Flat.	Curdy.	Rancid.	Fishy.	Unclean.	Aged.	Tallowy.	Metallic.	Too much.	Cloudy.	Too much.	Too little.		
VI a										+	+			Bitter	87
b															88
															93
c			±											Somewhat sour	89
				+											88
d				±			+								87
				±			+								90
e				+							±				87
				+						+				Musty	88
f				±							±				86
				±			+			+	+			Salvy	91
g				+							±				85
							+								90
VIII a	+							+							93
b				+				+						Oily	83
		+			+	+								Mealy, short grain	87
c						+		+							86
								+							86
d				+				+							80
		+				+								Mealy	88
e				+											82
					++				+						85
f				+				+							82
							+	+						Short grain	89
g				+											86
					++									Short grain, salvy	86
X a								+			+			Sour	92
b	+												+		90
				+	±										91
c								+			±				88
			±				±								91
d				+				+							85
					+						±			Color wavy	88
e				+											84
					+				+						88
f				+							±				88
					±									Pasty	88
g				+							±			Slightly mottled	85
					±										87
XI a						+				+				Sour, poor grain	87
b				+											88
			+	++											87
c			+			+					±				85
			+											Moldy	85
d				+										Moldy	85
				++							±			Moldy, mealy	85
e				+											85
															84
f				++		+									77
			+	+										Moldy	84
g				+											89
														Yeasty, mealy	83

TABLE IV.—Continued.

The Butter Scores.

Number.	Flavor.									Loose Moisture.		Salt.		Notes.	Score.
	Light.	Flat.	Curdy.	Rancid.	Fishy.	Unclean.	Aged.	Tallowy.	Metallic.	Too much.	Cloudy.	Too much.	Too little.		
XIII a															94
b				+											82
				++		+				+				Salvy	86
c						+									92
				+										Salvy	90
d				+			+								80
				++						+					88
e				+		+									78
			+											Moldy	85
f						+									78
			+				+								88
g				+											85
				±	±									Oily	87
XIV a										+				Poor grain, mottled	91
b							+								91
					+					+					89
c												+			92
				±	±					+					91
d				++				+				+			79
				+	+									Mottled	86
e							+					+		Sour	88
					±		+							Mottled	90
f				+										Somewhat mottled	87
							+					+			91
g															86
					±		+								90
XV a	+														96
b						+	+								85
				+	±										92
c			±											Sour	89
							+								92
d				+										Color wavy	84
					+										88
e					++										82
					+			+	+						90
f				+	±									Mottled	85
					+			±							88
g				+		+								Mottled	84
					±			+	+						90
XVI a											+	+		Undissolved salt	93
b				+							+			Bitter	83
				+							+	+			91
c						+					+	+			84
											+	+			92
d				+				+			+				78
					+						++			Oily	89
e				+							+	+			84
					+										86
f					+						+	+			83
					+							+			85
g				+							+				87
					+						+	+			87

TABLE IV.—Continued.

The Butter Scores.

Number.	Flavor.									Loose Moisture.		Salt.		Notes.	Score.
	Light.	Flat.	Curdy.	Rancid.	Fishy.	Unclean.	Aged.	Tallowy.	Metallic.	Too much.	Cloudy.	Too much.	Too little.		
XVII a	+		+								+		+		89
b							+								89
							+								91
c			±											Somewhat sour	89
			±												92
d					+			+							83
				±			+								90
e						+								Sour	87
					+									Oily, burnt	89
f						+								Sour	86
					+										88
g	+							+					+		87
					±									Somewhat oily	88
XVIII a										+	+	+		Undissolved salt	90
b				+			+								85
						+									90
c														Sour	89
															—
d				+			+								85
															—
e				+											86
					+							+			87
f				+								+			85
					+							+		Pasty, acid	88
g				+								+			84
					+							+			87
XIX a	+														94
b				+		+		+							85
					±										91
c	+												+		91
						+								Color wavy	92
d	+							+					+		85
					+								+	Oily, wavy, streaked	88
e		+		+			++						+	Short grain, mottles	80
						+	+						+	Mealy, doughy, vegetable	85
f						+							+		85
					±								+	Oily, wavy, salvy	88
g				+											83
						+							+	Color wavy	89
XX a															94
b				+				+							78
				+											91
c				±			+	+							83
					+										89
d					+										81
					++	+								Oily, pasty	87
e				++										Color wavy	84
					±			+	+						84
f				+	±									Wavy, dry, dull	84
					±			+	+					Wavy	84
g				+				+						Dry, dull	84
								+	+						83

TABLE IV.—Concluded.

The Butter Scores.

Number.	Flavor.									Loose Moisture.		Salt.		Notes.	
	Light.	Flat.	Curdy.	Rancid.	Fishy.	Unclean.	Aged.	Tallowy.	Metallic.	Too much.	Cloudy.	Too much.	Too little.		Score.
XXI a			+				+				+				85
b	+												+	Insipid, poor grain	85
		+				+									87
c		+						+					+	Dry	83
			+	+		+									88
d				++				+					+	Dry	78
		+											+		89
e				+		+					+				79
			+	±							+				86
f						+							+		75
			+	±									+	Sickening, yeasty, pasty	84
g						+									75
			+			+					+			Moldy, yeasty, wavy, short grain	86
XXII a										+	+	+		Weak body	87
b				+						+	+	+			80
					±					+	+				90
c											+	+		Sour, butter color	87
				+							+	+			91
d				+							+	+			84
					±						+	+			91
e				+							+	+		Too high color	83
					+						+				88
f				+							+	+		Tastes of butter color	85
					+				±		+				86
g				+							+			Tastes of butter color	85
					+						+				87

A very marked instance of scores which are not all in agreement is shown in the case of lots I, III and V, all of which were made from the same lot of cream, I being churned sweet after pasteurizing, III, sweet without pasteurizing, and V pasteurized and then ripened with a pure starter. In the first February score it will be noted that V was given a very low score as compared with I, while in the second score the numerical values are equal although the flavor of these two samples was very different, I being quite light and mild, while V was rather high in flavor. In the one case, V was scored down for this high flavor which to the second scorer did not seem objectionable, although admittedly present. These butters were more than a year old at this time.

Score.	I	III	V
Foster	88	84	83
Rabild	91	86	91

In regard to the flavors which characterize the different butters the agreement is very much closer, although even here some surprising differences are noted. This is due, in part, no doubt, to the sequence in which the butter happened to come at the time of scoring; any particularly good or bad butter influencing to some extent the score of the butter which immediately followed it. From our own experience and the contradictory evidence obtained at other places where similar scores have been made the basis for judging between various methods of manufacture, we feel that reliable inferences may be drawn only where there is close agreement between the scores of at least three experienced scorers, and the number of samples scored is relatively large.

EFFECT OF TEMPERATURE.

With few exceptions all the samples of butter kept in the college storage where the temperature was above the freezing point—about 5° C.—had become entirely unfit for ordinary use before November. The best samples were scored as follows:

Sample.	November	February
X	78	
XIV	75	78
XV	78	
XVI	76	
XVII	88	
XVIII	78	78
XIX	77	
XXII	79	83

The butters were in most cases very rancid, but no other flavors were noted except that of moldiness. A number of these samples showed moldy in the trier and molds developed in considerable numbers on the plates, as seen in table VIII, lots II, XI, XIII, and XXI.

EFFECT OF WATER CONTENT.

The water content of all the samples included in the regular examination was very uniform and averaged about 13%, varying between 12% and 14.67%. Even though there had been a greater difference it would be obviously unfair to compare, with respect to any single factor, lots of butter which were made under such different conditions. The average scores of the eight samples with the higher and the eight samples with the lower water content were:

Score	Average water content	Fresh	b	c	d	e	f	g
Foster	13.73%	91	85	86	82	84	83	85
	12.34%	92	85	87	83	84	84	85
Rabild	13.73%	....	90	90	89	88	88	88
	12.34%	....	90	90	88	86	87	87

EFFECT OF SALT.

The salt content of the samples classed them all the way from very low to very high salted butters, varying between 1.06 and 3.78%. Here also we can show no difference in keeping quality due to this single factor. Dividing the lots into three groups according to salt percentages, we get the following average scores:

Score	Average salt content	Fresh	b	c	d	e	f	g
Foster	1.22%	91	86	88	83	83	84	83
	2.22%	92	83	87	82	82	82	86
	3.28%	90	87	89	83	86	84	86
Rabild	1.22%	....	90	91	88	87	87	86
	2.22%	....	89	90	89	86	87	87
	3.28%	....	90	89	88	87	88	88

EFFECT OF STARTER.

The use of a starter in preparing the cream for churning appears to have had a decided influence upon the scores, for, without a single exception, the average scores of the eight lots where a pure culture starter was not used are lower than the averages of the eight lots where a commercial pure culture starter was employed. It is, of course, true that at creameries where pure culture starters were used, other conditions also are likely to have been better. The average scores were:

Score	Method	Fresh	b	c	d	e	f	g
Foster	Without starter	90	84	87	82	83	82	84
	With starter	92	86	88	83	85	85	86
Rabild	Without starter	....	89	89	88	86	86	86
	With starter	....	91	90	89	87	88	88

GATHERED VS. WHOLE MILK CREAM.

As between gathered cream and cream separated from whole milk, our scores are decidedly contradictory. There were five lots made from gathered cream, and six lots from whole milk cream, the average scores of which follow. In this case the scorers failed to agree.

Score	Method	Fresh	b	c	d	e	f	g
Foster	Gathered cream	91	87	89	82	85	82	86
	Whole milk	92	83	87	82	84	85	85
Rabild	Gathered cream	....	88	89	87	86	88	87
	Whole milk	....	91	91	89	87	87	87

HIGH ACID BUTTER.

The average score of the samples with high acidity (II, XI, XIII and XXI) is below the total average. These came from creameries where the conditions were bad. Number II had old buildings and apparatus and questionable water supply; at XI construction operations were in progress; XIII had dirty rooms and bad management, and at XXI all conditions were bad (See Tables II and VI).

Score	Group	Fresh	b	c	d	e	f	g
Foster	High acid	90	85	88	81	82	79	83
	Total average	91	85	88	83	84	83	85
Rabild	High acid	....	88	88	87	86	86	86
	Total average	....	90	90	89	87	87	87

CHEMICAL ANALYSIS.

LIMITS OF ANALYTICAL ERROR.

In the accepted chemical determinations (Table V) there was never a discrepancy greater than .04 of one per cent between duplicate results for water and salt, i. e., the average was within .02 of one per cent of the highest and lowest results obtained. The results for curd and sugar, and, therefore, also for total fat, varied as much as .2 of one per cent. The acid determinations usually checked exactly, but occasionally varied as much as 0.2 cc. of $^N/_1$ acid per 100 grams of butter.

TABLE V.

Results of Chemical Analyses.

Sample	Date Finished	Water	Fat	Salt	Curd and Sugar
I	7-1-07	10.72%	86.00%	2.42%	.86%
III	7-1-07	13.12%	82.20%	3.33%	1.35%
V	7-1-07	12.59%	83.42%	2.96%	1.02%
IX	6-28-07	14.32%	81.93%	2.45%	1.30%
II	7-1-07	12.13%	85.99%	1.06%	.82%
IV	6-29-07	14.67%	81.18%	3.16%	.99%
VI	6-29-07	12.36%	83.70%	2.95%	.99%
VIII	6-28-07	13.78%	82.90%	2.00%	1.31%
X	6-28-07	12.48%	84.86%	1.32%	1.33%
XI	6-28-07	13.08%	83.42%	2.63%	.86%
XIII	6-27-07	12.48%	84.85%	1.79%	.87%
XIV	6-26-07	13.70%	82.67%	2.75%	.88%
XV	6-20-07	13.41%	83.69%	1.83%	1.06%
XVI	6-21-07	13.23%	81.95%	3.76%	1.05%
XVII	6-21-07	13.37%	84.14%	1.11%	1.37%
XVIII	6-22-07	12.07%	82.98%	3.78%	1.17%
XIX	6-26-07	12.65%	85.30%	1.13%	.91%
XX	6-22-07	12.60%	84.21%	2.49%	.70%
XXI	6-26-07	13.81%	83.88%	1.50%	.80%
XXII	6-22-07	13.85%	82.62%	2.55%	.98%
Average	....	13.10%	83.65%	2.24%	1.01%

The water content of the different samples was nearly the same, the greatest variations being between 12.07% and 14.67%. The salt content varied more, between 1.06 and 3.78%.

Analyses of samples taken from three tubs of the same lot gave the following results:

Sample	Acidity	Water	Fat	Salt	Curd and Sugar
VIa..........	2.4	12.36	83.70	2.95	.99
VIb..........	2.3	12.26	83.74	3.03	.96
VIc..........	2.4	11.78	84.21	2.98	1.03

In the November and February examinations it was not considered necessary to determine again the amounts of water, curd and salt in the butter, since, under the conditions there was no possibility of their having materially changed in amount. Although the protein substances had probably altered, having been split into soluble products, the analytical difficulties are so great and the errors so large that little would have been gained in the running of complete analyses.

FREE ACIDS.

The fat was decomposed in all samples of the *a* storage; the increase of free acids is very small in the samples VIIIa_2 and a_3, XIVa_2 and a_3, and XXa_2 and a_3. The samples kept in the colder storages gave different results. The renovated butter, IX, and four of the 16 regular samples, namely II, XI, XIII and XXI, had a distinct increase of free acids; these samples had also very poor creamery conditions, they scored low, and contained plenty of Oidium lactis. The other 12 regular samples had either a slight increase or decrease of acidity; in the average the increase is a little larger, showing a very slight decomposition of fat. Only two tubs out of 72 have an increase of .3°, the rest being lower. This may be within the probable error. That acidity and score are not always related to each other, is plainly demonstrated by the samples I and V, which, after 12 months of storage, had still the score 91, though they had an acidity of 3.3 and 4.6.

TABLE VI.

Results of Acid Determinations cc of N/1 acid per 100 grams of Butter.

Sample	Fresh	November				February			
	a	a_2	b	c	d	a_3	e	f	g
I..........	(5.3)*	7.9	3.2	....	....	9.4	3.3	....	....
III..........	(10.4)	18.1	5.2	....	....	19.2	5.6	....	....
V..........	(6.6)	7.8	4.3	....	....	8.7	4.6	....	....
IX..........	(5.9)	7.3	5.9	6.1	6.5	8.4	6.8	6.6	6.1
II..........	(2.5)	8.7	2.3	2.7	3.8	11.7	3.0	3.7	3.6
IV..........	(2.4)	4.5	2.2	2.3	2.3	5.9	2.4	2.4	2.4
VI..........	(2.4)	5.1	2.1	2.2	2.2	6.7	2.2	2.0	2.3
VIII..........	(2.3)	2.5	2.1	2.2	2.2	2.6	2.2	2.1	2.2
X..........	(2.1)	2.7	2.1	2.1	2.1	3.6	2.2	2.2	2.3
XI..........	(3.1)	7.7	4.9	4.5	4.8	8.6	5.6	4.8	5.7
XIII..........	2.8	6.7	3.1	3.1	3.1	7.8	3.8	3.2	3.4
XIV..........	2.0	2.2	1.9	1.9	1.9	2.5	2.0	1.9	2.0
XV..........	1.9	2.8	1.9	1.8	1.9	2.9	2.0	1.9	2.0
XVI..........	2.2	3.1	2.1	2.1	2.3	3.4	2.3	2.2	2.3
XVII..........	1.8	3.3	1.9	1.8	2.0	3.1	2.1	1.9	2.0
XVIII..........	2.1	3.2	2.3	2.2	2.3	3.5	2.4	2.3	2.3
XIX..........	1.5	4.1	1.6	1.6	1.6	3.9	1.6	1.6	1.8
XX..........	1.7	2.3	1.5	1.5	1.5	2.5	1.6	1.6	1.7
XXI.	2.6	7.2	3.4	3.0	3.2	8.9	4.4	3.3	4.1
XXII..........	2.1	2.9	2.1	2.1	2.0	3.0	2.1	2.1	2.1

*Nos. I–XI not strictly fresh when first tested.

The samples I–XI could not be tested when perfectly fresh and therefore their acidity is sometimes higher than that of the cold storage samples.

VOLATILE ACIDS AND ESTERS.

The results of the determination of volatile acids and esters in series *a* are given in Table VII, which shows no apparent relation between the total amount of free acid and the amount of volatile free acid. This may be due to the great liability to error in the determination of the free volatile acids together with the very small amount of total free acid. Esters were found only in sample III. The butters of the other series, showing no marked increase in acidity, were not investigated for volatile acids and esters.

TABLE VII.

Volatile Acids and Esters cc N/1 Na OH per 100 grams of Butter.

Sample *a*.	Fresh	November		
	Total Acid	Total Acid	Volatile Acids	Esters
I	(5.3)*	7.9	1.2	0
III	(10.4)	18.1	3.3	1.2
V	(6.6)	7.8	1.1	0
IX	(5.9)	7.3	0.5	0
II	(2.5)	8.7	1.4	0
IV	(2.4)	4.5	1.2	0
VI	(2.4)	5.1	0.7	0
VIII	(2.3)	2.5	0.5	0
X	(2.1)	2.7	1.1	0
XI	(3.1)	7.7	1.1	0
XIII	2.8	6.7	1.7	0
XIV	2.0	2.2	1.2	0
XV	1.9	2.8	0.5	0
XVI	2.2	3.1	0.6	0
XVII	1.8	3.3	1.5	0
XVIII	2.1	3.2	1.4	0
XIX	1.5	4.1	1.0	0
XX	1.7	2.3	0.8	0
XXI	2.6	7.2	0.9	0
XXII	2.1	2.9	1.0	0

*Nos. I–XI not strictly fresh when first tested.

MICRO-ORGANISMS.

Table VIII gives the counts and species of micro-organisms found in butter. Column *a* is the fresh butter; columns a_2, *b*, *c*, and *d*, the four different cold storages in November, and columns a_3, *e*, *f*, and *g*, the same storages in February. The numbers are average numbers from the three different dilutions (see p. 10). In some cases the numbers in the different dilutions were so contradictory that the organisms may not have belonged to the original butter sample, being merely contaminations. In these cases we did not give the number but simply stated their presence by a (—) sign.

THE BACTERIA.

All micro-organisms in our work were isolated in the same way. The agar plates were first counted and then the different colonies were isolated into broth; from this, gelatin plates were made as soon as the broth culture was grown, usually after 1 or 2 days. From this gelatin plate the description of the gelatin colonies was taken, and the micro-organisms isolated on slant agar. The two days old agar streak was used for the morphology. From this culture transfers were made into gelatin, broth and litmus milk; most cultures were grown in litmus milk at 20 and 37°. Some were also transferred on potatoes. The broth culture was used for the inoculation of the fermentation tubes containing dextrose, lactose and saccharose in sugar-free broth.

After we were through with all examinations we tried to identify the bacteria as far as possible. We separated them first according to their morphology into *Cocci*, *Bacteria* (non-motile rods), *Bacilli* (motile rods), *Streptothrix* (this may belong to some other group; we could not find a suitable description and classification of this type of micro-organism, and therefore we used the same name that was used by Reinmann and Jensen), *Yeasts* (all of them non-spore-producing), and *Molds*. The groups of bacteria were subdivided into liquefying and non-liquefying, and acid and non-acid in dextrose broth; this classification according to the physiological properties seeming very valuable to us, since the physiological actions, only, have an influence upon the decomposition of butter. Esten, in his latest publication, "*Sources of Bacteria in Milk*," uses a similar classification.

When we came to the identification of the bacteria, we found that the descriptions of bacteria in Migula's *System der Bacterien* and in Chester's *Manual of Determinative Bacteriology* were so incomplete and paid so little attention to the physiological changes that we did not dare to use these names for our bacteria. Thus the "*Classification of Dairy Bacteria*," by Conn, Esten and Stocking was the only classification that enabled us to identify the greater part of our organisms. This work refers only to bacteria which are found in milk and milk products, and its use therefore is limited, but the method of description makes it really possible to compare and identify bacteria, whereas in using the other works with their scanty

TABLE VIII.

Kind and number of organisms in all butter samples.

Lot I

	a_1	a_2	b_2	a_3	b_3
Bacterium lactis acidi	1,200,000	0	144,000	0	82,000
Micrococcus lactis aureus	....	....	....	....	1,200
" " varians	....	....	1,000	....	....
" " albidus	....	....	....	(—)	....
Bacterium lactis Connii	....	100	7,000	....	....
" I A	6,000	....	....	....	....
" I B	....	100	....	....	....
" I C	....	....	1,000	....	....
" lactis album	....	....	....	....	1,500
" " Limburgii	....	100	....	....	....
Bacillus Zenkeri	1,000	....	....	....	....
" I D	6,000	....	....	....	....
" fluorescens liquefaciens	1,000	....	....	....	....
Rapidly liquefying yeast	(—)	....	....	....	....
Small irregular yeast	1,000	....	600	....	1,500
Round yeast	....	1,200	....	....	....
Pink yeast	....	(—)	200	....	....
Oidium lactis	300	....	100	....	....
Penicillium glaucum	....	700	(—)	....	....
Aspergillus glaucus	....	1,000	....	....	....

Lot III

	a_1	a_2	b_2	a_3	b_3
Bacterium lactis acidi	24,650,000	0	1,200,000	....	42,000
Micrococcus lactis aureus	....	....	8,000	....	....
" " varians	30,000	....	....	....	2,800
" " varians O	1,000	....	....	....	....
Bacterium lactis Connii	....	....	1,000	100	3,500
" " album	....	....	6,000	....	....
" " luteum	....	1,000	....	....	....
Bacillus Zenkeri	8,000	....	....	....	....
" III A	....	....	27,000	....	....
" III B	100	....	....	....	....
" lactis Robertii	66,000	....	....	....	....
" " tenuis	....	....	1,000	....	....
" fluorescens liquefaciens	30,000	....	....	....	....
Streptothrix	....	400	700	....	600
Small irregular yeast	....	(—)	....	....	100
Oidium lactis	(—)	....	....	....	....
Penicillium glaucum	....	(—)	....	....	....
Aspergillus glaucus	....	(—)	....	....	....

TABLE VIII.—Continued.

Lot V

	a_1	a_2	b_2	a_3	b_3
Bacterium lactis acidi	3,200,000		90,000		22,000
Micrococcus lactis albidus	600,000				
“ “ varians O	200				
Bacterium lactis Connii			5,000		400
“ V A	1,000				
“ lactis cretaceum				200	
“ “ citronum			2,000		
Bacillus lactis citreus					1,800
“ “ Pruchii		100		500	
“ fluorescens liquefac	1,000				
Streptothrix		(—)			100
Small irregular yeast					100
Oidium lactis	100				
Penicillium glaucum		(—)			
Aspergillus glaucus		(—)	(—)		

Lot IX

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	1,900,000		480,000	460,000	380,000		5,000	14,000	10,000
Galactococcus versicolor					1,000			1,000	
Micrococcus lactis varians			2,000		2,000			5,000	5,000
“ “ “ var. O	1,000								
“ “ albidus	1,000								
Bacterium lactis Connii				1,000					
“ luteum A	75,000			10,000			4,000		
Bacillus fluor. non-liquefac			1,000						
“ IXA								100	100
Streptothrix	20,000	10,000	1,000		1,000	(—)			
Rapidly liquefying yeast	3,000		800	5,000			300	200	300
Small irregular yeast	11,000		60,000	16,000			100,000	27,000	25,000
Round yeast		304,000				250,000			
Maltose yeast					34,000				
Pink yeast	5,000		1,000		2,000	100			100
Oidium lactis	(—)	10,000	1,000	1,000	300	10,000	300		300
Penicillium glaucum	(—)				(—)				
Aspergillus glaucus	(—)				(—)				

TABLE VIII.—Continued.

Lot II

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	26,000,000	0	750,000	390,000	750,000	3,500	300,000	415,000	650,000
Streptococcus lactis acidi I v. B.						1,400			
Galactococcus versicolor							700		
Micrococcus lactis varians			4,000		200		8,600	5,500	15,000
“ “ “ var. O.	18,000								
“ “ albidus					3,000				
Bacterium lactis citreum II	15,000			7,000					
“ II A				21,000					
Bacillus fluor. non-liquef	1,000			100					
“ II B	11,000								
“ lactis cochleatus	1,000								100
“ “ mycoides		1,000							
Streptothrix				100	100		100	100	200
Rapidly liquefying yeast				35,000					
Small irregular yeast		10,000	18,000	88,000	6,000	3,600	400	600	200
Maltose fermenting yeast		9,100							
Oidium lactis			100						
Penicillium		(—)							
Aspergillus glaucus	(—)	(—)	200						

Lot IV

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	3,140,000	0	1,400,000	776,000	1,300,000	0	655,000	540,000	751,000
Micrococcus IV A					2,000		12,000		12,000
“ lactis varians	40,000			12,000				13,000	
“ “ “ var. O	10,000								
“ “ aureus			9,000						
“ “ albidus			5,000		2,000				
Bacterium lactis citreum II	10,000								
“ “ Connii								300	200
“ “ Burri	3,000				(—)				
Bacillus lactis Harrisonii		(—)		(—)					
“ “ moruloideus						100			
Streptothrix								100	100
Small irregular yeast	4,000	100	2,000	5,000	4,000	800	600	2,000	10,000
Round yeast								22,000	
Pink yeast				(—)					
Oidium lactis			200						
Penicillium glaucum	(—)	(—)		(—)		400			
Aspergillus glaucus					(—)				

TABLE VIII.—Continued.

Lot VI

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	10,000,000	0	1,700,000	1,600,000	570,000	0	520,000	600,000	130,000
Micrococcus lactis aureus	6,000		2,000	3,000	1,000		3,500	5,000	1,500
Galactococcus versicolor				1,000					
Micrococcus lactis albidus		3,000			2,000				
“ “ citronus	8,000								
“ “ varians var. O	1,000								
Bacterium lactis Connii	10,000		1,000		1,000				
“ “ album						(—)	300		
“ “ “ var. A.				2,000				400	
Pseudomonas lactis anana		(—)							
Bacillus lactis tetragenes						100			
“ “ tenuis var. A.									
Streptothrix	100				(—)		100	100	400
Rapidly liquefying yeast			100						
Small irregular yeast		3,000	1,000	500	12,000		600	2,600	27,000
Pink yeast				300					200
Penicillium glaucum		200		200					
Aspergillus glaucus				200	100	500			

Lot VIII

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	550,000	0	30,000	20,000	17,000	300	6,000	6,000	5,000
Micrococcus lactis albus				(—)					
“ “ albidus	2,000								
Bacterium lactis Connii	1,000								
“ “ aureum I.					100				
“ VIII A.	3,000		300	1,400	200				2,000
“ VIII B.							100		
“ VIII C.						300	2,800	2,300	
Bacillus lactis sulcatus					200				
“ “ tetragenes	1,000								
“ “ cochleatus		(—)				500			600
“ “ plicatus			100	100			100	100	100
Streptothrix	100				(—)			1,300	
Small irregular yeast			600	100			900	100	200
Penicillium glaucum	(—)	30,000		100		2,000			
Aspergillus glaucus				100					
Botrytis				(—)					

TABLE VIII.—Continued.

Lot X

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	3,000,000	0	72,000	88,000	10,000	0	5,000	8,000	3,000
Streptococcus lacticus I var. B	....	....	....	1,000	....	....	....	800	....
Micrococcus X A	....	....	1,000	....	100	....	....	....	....
“ lactis albus	(—)	....	....	200	....	....	....	100	....
“ “ varians	1,000	....	....	....	....	....	1,800	....	1,000
“ “ albidus	1,000	....	....	....	....	....	3,600	....	....
Bacterium lactis aureum I	....	(—)	....	....	(—)	....	....	....	....
“ X B	....	....	....	....	....	....	....	1,400	....
“ X C	....	....	....	700	....	....	....	1,000	....
Bacillus lactis Pruchii	(—)	....	....	100	....	....	8,000	7,000	1,000
Streptothrix	(—)	....	....	....	(—)	....	....	....	....
Rapidly liquefying yeast	....	....	....	....	40,000	....	....	3,000	....
Small irregular yeast	....	36,000	56,000	41,000	88,000	140,000	45,000	15,000	26,000
Round yeast	....	....	....	600	....	....	....	....	....
Maltose yeast	22,000	....	....	....	....	....	....	....	....
Oidium lactis	....	....	....	....	....	(—)	....	....	6,000
Penicillium glaucum	....	....	....	....	(—)	....	....	(—)	(—)
Mucor	....	....	....	....	....	....	....	(—)	....

Lot XI

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	20,750,000	3,000	1000,000	2000,000	1500,000	1,750,000	212,000	760,000	265,000
Bacterium lactis Connii	20,000	....	....	1,000	....	....	....	....	....
“ XI A	....	....	....	....	....	(—)	....	....	....
“ XI B	....	....	....	100	....	....	6,000	....	....
“ lactis album	....	....	....	....	....	1,000	....	....	....
“ “ Gorinii var. B	....	....	....	....	....	....	....	6,000	....
“ “ Marshallii	....	2,000	....	....	....	....	....	....	....
Bacillus fluor. non-liquefac	20,000	....	....	....	....	....	....	....	....
“ lactis cochleatus	30,000	100	....	....	....	100	....	200,000	....
Streptothrix	....	....	....	....	(—)	....	....	....	....
Rapidly liquefying yeast	....	....	....	400	....	....	200	300	100
Small irregular yeast	....	40,000	....	....	4,000	....	56,000	....	11,000
Maltose fermenting yeast	....	....	6,000	(—)	....	6,000	....	....	....
Oidium lactis	42,000	....	10,000	10,000	10,000	....	7,500	10,000	6,500
Penicillium glaucum	....	....	....	....	....	(—)	....	....	....
Aspergillus glaucus	1,000	100	....	....	....	....	....	....	....

TABLE VIII.—Continued.

Lot XIII

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	15,000,000	6,000	3000,000	2500,000	1650,000	3,000	1000,000	1725,000	1000,000
Micrococcus lactis varians			2,000	1,000	1,000		2,000	1,800	1,000
" " albidus									300
Bacterium lactis Connii								600	
" " non-acidi			2,000		2,000				
" " aureum II	7,000					3,000			
" " citronis	5,000								
" XIII A					(—)				1,000
Bacillus fluorescens non-liquef	(—)								
" lactis distortus							1,500		
" fluoresc. liquefaciens			100						
" lactis cochleatus								2,600	100
Streptothrix				(—)				100	
Rapidly liquefying yeast							100	100	100
Small irregular yeast	31,000		8,000	6,000	30,000	6,000	13,000	8,000	2,000
Round yeast		150,000				40,000			14,000
Cream colored yeast				7,000				100	
Oidium lactis	14,000	600	1,800	5,000	1,800	500	3,000	2,500	2,000
Penicillium glaucum	10,000				2,000	2,000			
Mucor					2,000				

Lot XIV

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	3,000,000	1,000	145,000	285,000	185,000	700	75,000	82,000	22,500
Galactococcus versicolor	12,000					1,000			
Micrococcus lactis varians	6,000	200	2,400	2,000	1,000	400	2,400	2,800	4,600
" " " var. O	(—)								
Bacterium lactis Connii	1,000		1,000	1,000			1,100		
" XIV A					400				
Pseudomonas lactis contorta		400							
Bacillus XIV B							(—)	2,400	(—)
Rapidly liquefying yeast				200	300				
Small irregular yeast		4,000		2,000	700	3,200	3,300	2,700	2,400
Maltose yeast			4,000						
Oidium lactis		200							
Penicillium glaucum		100							
Aspergillus glaucus		200				(—)			

Lot XV

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	7,650,000	3,000	765,000	470,000	520,000	2,000	125,000	350,000	170,000
Micrococcus lactis varians	2,000			2,000	1,000	1,000	2,500		2,000
" " " var. O	2,000								
Bacterium lactis Connii	1,000		200						
" " Gorinii var. A				800	1,000		1,000	1,500	1,000
Streptothrix	1,000				(—)				200
Rapidly liquefying yeast	1,000		100		600				400
Small irregular yeast		123,000	1,000	600	3,000	36,000	20,000	2,000	9,300
Penicillium glaucum		2,000				1,000			
Aspergillus glaucus		(—)							

TABLE VIII.—Continued.

Lot XVI

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	3,600,000	4,000	762,000	685,000	575,000	1,400	325,000	325,000	225,000
Micrococcus lactis varians	6,000	700	1,000	7,000	2,000	300	5,000	5,000	4,500
“ “ “ var. O	2,000								
Bacterium lactis Connii	4,000		100	600					
“ “ non acidi							1,100		3,000
“ “ lobatum	(—)							1,000	
Streptothrix	3,000			100					
Small irregular yeast		20,000	700	400	2,000		1,400	300	400
Round yeast						30,000			
Maltose yeast									700
Oidium lactis	2,000								
Penicillium glaucum	4,000	300			(—)				

Lot XVII

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	25,000,000	25,000	1,525,000	1,575,000	1,650,000	45,000	1,125,000	2,000,000	1,000,000
Micrococcus lactis aureus				1,000			2,000		
“ “ varians	1,000		1,000			3,000		2,000	3,000
Bacterium lactis Connii	48,000			2,000					2,000
“ “ lobatum	1,000		2,000	1,000			600	300	100
“ “ plicatum							2,500	2,000	
Bacillus fluorescens liquefaciens					2,000				
“ XVII A					300		1,800		
“ lactis cloacæ A								1,000	
Streptothrix	(—)				1,000				
Rapidly liquefying yeast						100			
Small irregular yeast		528,000	1,000	1,000	23,000		3,000	2,000	7,000
Round yeast						112,000			
Penicillium glaucum	(—)	65,000							
Aspergillus glaucus	(—)								

Lot XVIII

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	14,000,000	4,000	4200,000	4300,000	4000,000	10,000	1000,000	1200,000	1780,000
Micrococcus lactis aureus			100			700	2,000		
“ “ varians	70,000	1,500	2,000	3,000	7,000			3,000	5,000
“ “ “ var. O	20,000			300					
Bacterium lactis Connii				1,000					1,000
“ “ citreum II	20,000								
“ “ magnum		100	1,000						
“ “ Gorinii							3,000	2,000	
Bacillus lactis cochleatus					1,000		(—)	300	
Slowly liquefying yeast	2,000				2,000				
Small irregular yeast		40,000	3,000	6,000	4,000	5,000	5,000	1,000	6,900
Pink yeast		300					100		100
Oidium lactis	(—)								
Penicillium glaucum	(—)	(—)							
Aspergillus glaucus	(—)			(—)	(—)				

TABLE VIII.—Continued.

Lot XIX

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	4,500,000	3,000	570,000	850,000	750,000	0	50,000	300,000	100,000
Micrococcus lactis aureus	15,000	....	3,000	....	3,000	....	....	....	....
" XIX A	8,000	....	....	....	....	....	....	....	....
" lactis varians	....	....	....	3,000	....	....	....	2,000	....
" " " var. O	1,000	....	....	....	....	....	....	....	....
" " albidus	2,000	....	....	....	....	12,000	....	....	....
Bacterium lactis Connii	....	....	3,000	100	....	....	....	....	....
" " lobatum	....	1,000	....	....	....	....	1,000	11,000	....
" " Marshallii	....	2,000	....	....	....	....	....	....	1,000
" " album	....	....	....	....	....	....	4,000	....	....
Bacillus fluorescens non-liquef	....	....	....	....	....	1,000	....	....	....
Streptothrix	(—)	....	....	100	....	....	....	....	....
Rapidly liquefying yeast	....	....	....	....	....	....	....	....	600
Small irregular yeast	....	....	16,000	2,000	40,000	1,180,000	93,000	16,000	700,000
Round yeast	....	1800,000	....	....	250,000	....	....	4,000	....
Pink yeast	....	....	....	....	200	....	....	....	200
Penicillium glaucum	1,000	75,000	....	....	....	25,000	....	....	....
Aspergillus glaucus	(—)	....	....	....	....	....	....	....	....

Lot XX

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	1,500,000	1,000	200,000	200,000	200,000	300	100,000	55,000	65,000
Micrococcus lactis aureus	....	....	2,000	....	5,000	200	....	....	....
" " varians	....	....	....	....	....	....	1,000	500	1,000
" " " var. O	10,000	....	....	1,000	....	....	....	....	....
Bacterium lactis aureum II B	....	....	....	1,500	....	....	....	....	....
Bacillus lactis Pruchii	....	....	....	....	1,000	....	....	....	....
Streptothrix	....	....	....	....	(—)	....	100	....	....
Small irregular yeast	....	55,000	600	2,000	2,000	500	600	1,300	1,200
Round yeast	....	....	....	....	....	6,000	....	....	....
Cream colored yeast	(—)	....	....	....	....	....	....	....	....
Aspergillus	(—)	....	(—)	....	....	....	....	....	....

TABLE VIII.—Continued.

Lot XXI

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	3,000,000	0	460,000	290,000	1800,000	0	150,000	50,000	230,000
Micrococcus lactis aureus	35,000			30,000					
“ “ varians			20,000		1,000		10,000	35,000	20,000
“ “ albidus			1,000	2,000					
Bacterium lactis Connii				1,000	2,000				
“ “ salmonis	62,000		1,000	2,000					
“ XXI A				1,000					
“ lactis album	6,000								
“ “ Gorinii								2,000	
Bacillus Zenkerii	1,000							2,000	
“ fluorescens liquef								100	
“ mesent. fuscus					1,000		16,000	3,000	4,000
Streptothrix	(—)			1,000					
Small irregular yeast		3960,000	10,000		1,800	2000,000	9,000	4,000	6,000
Oidium lactis	50,000	20,000	20,000	5,000		4,000	5,000	3,000	5,000
Penicillium glaucum	(—)	500,000			(—)	170,000			
Aspergillus glaucus	(—)		4,000						

Lot XXII

	a_1	a_2	b	c	d	a_3	e	f	g
Bacterium lactis acidi	6,000,000	10,000	2630,000	3190,000	290,000	6,300	1300,000	625,000	1250,000
Micrococcus lactis aureus				3,000	2,800		1,000		
“ “ varians								1,000	
“ “ albus	3,000								
Bacterium lactis Connii			200	500	200				
“ XXII A	1,000					1,500			
“ XXII B						200			
“ lactis Marshallii									1,000
Bacillus Zenkerii									400
“ lactis cochleatus						200	300		
Streptothrix				1,000	200				
Rapidly liquefying yeast				100					
Small irregular yeast			3,000	2,000	15,000		1,000	2,000	
Round yeast		250,000				53,000			
Maltose yeast									1,000
Pink yeast	1,000			100					
Oidium lactis					10,000				
Penicillium glacum	(—)	15,000	200						
Aspergillus glaucus			(—)	1,000		1,000			

descriptions one is never certain that two bacteria are alike, or, on the other hand, one may have a choice between two, three or perhaps four really identical germs which have been given different names. The classification of Conn, Esten and Stocking may have its mistakes—and probably there are some mistakes in the grouping of the different varieties—but it is a book that can easily be used by every bacteriologist. It is possible that the names which we gave to our bacteria are not always the right names; and we may have grouped together different bacteria under the same name, but the error will not be very large, since their most prominent characteristics, morphological as well as physiological, are alike.

The species that we have found most frequently in our butter is the *Micrococcus lactis varians,* a somewhat indefinite group of *Cocci* with varying qualities; they are slowly liquefying yellow cocci, producing acid in dextrose, lactose and sometimes in saccharose. The acid production varies as well as the liquefaction, and often, though not always, the very slowly liquefying varieties give a more pronounced acidity than the more rapid liquefiers. *Staph. pyog. aureus* belongs to this species. There is no distinct line between these and the non-liquefying *Micrococcus lactis aureus,* because some liquefy in 5 days, some in 10, some begin after 30 days, and some which liquefied very slowly the first time, when transferred again, began to liquefy after a few days. The color varies in the same way. We often found in fresh butter an orange variety, slowly liquefying and producing acid in all three sugars, and called this *Micrococcus lactis varians O.* (orange). The *M. l. varians* is often found in the udder of the cow, and therefore we understand its frequency in butter. The *M. l. aureus* is perfectly described by calling it the non-liquefying variety of *M. l. varians.* The *M. l. albidus* is characterized in the same way as a white variety of *M. l. varians.* Conn, Esten and Stocking suppose that these three organisms all belong to the same species. This agrees with the observation that very often the one type disappears as soon as the other appears, e. g., IV, XX, XXI. The other Cocci are all found in very small numbers and so seldom that it is not worth while giving their description. They may be looked up in the original. Those which are not named are briefly described on page 38.

The genus Bacterium is not at all so frequent but there are more different species and many of them could not be named at all. These are described on page 38. The most frequent is *Bacterium lactis Conni,* a non-liquefying, non-acid rod which makes milk alkaline without any digestion. Conn, Stocking and Esten say that they found this bacterium frequently in New York milk, and in the Camembert cheese.

Bacterium lactis lobatum is a slowly liquefying orange bacterium, producing acid in dextrose, lactose and saccharose and digesting the milk with acid reaction to a pasty liquid. *Bacterium lactis album* is a slow liquefier, not acid, curdling and digesting milk with slightly alkaline reaction. *Bacterium lactis Gorinii* is a liquefying bacterium, producing acid in dextrose and saccharose, but not in lactose. Milk is made alkaline and completely digested.

The motile bacteria occur in still smaller numbers. Only *Bacillus lactis cochleatus* and *Bacillus lactis Pruchii* are found several times. The first liquefies slowly, makes dextrose and saccharose, but not lactose, acid. Milk is usually curdled and peptonized with alkaline reaction. *Bacillus lactis Pruchii* produces acid in dextrose only, liquefies rapidly, curdles and digests milk to a yellowish paste.

TABLE IX.

Description of all Bacteria not named.		Liquef.	Acidity.			Diameter.	Length.	Pigment.			Scum.	Litmus Milk.				
			D	L	S			White.	Yellow.	Orange.		Curded.	Acid.	Alkal.	Discol.	Pepton.
Micrococcus	X A	0	0	0	0	1.0	......	0	+	0	0	0	0	0	0	0
	XIX A	0	+	0	+	.8	......	0	+	0	0	0	0	+	0	0
Bacterium	XXI A	0	0	0	0	.8	1.2	+	0	0	+	0	±	0	+	+
	I B	0	0	0	0	1.0	3.0	0	0	+	+	0	0	+	0	0
	XI A	0	+	0	+	.8	1.6	+	0	0	0	0	0	+	0	0
	VIII A	0	+	±	0	.6	1.0	0	+	0	0	0	+	0	0	0
	VIII B	0	+	0	+	.8	1.2	0	+	0	0	0	0	0	0	0
	I A, XI B, XXII A	0	+*	0	0	.8	1.2	+	0	0	+	0	0	+	0	0
	XIV A	+	0	0	0	.8	1.0	+	0	0	r	0	0	+	0	0
	I C	+	0	0	0	.5	.8	0	+	0	0	+	+	0	+	?
	II A	+	0	0	0	.8	1.5	0	+	0	0	0	0	0	0	0
	X B	+	0	0	0	.8	1.5	0	+	0	0	0	0	+	0	0
	X C	+	0	0	0	.8	1.5	0	+	0	0	+	0	0	+	+
	XIII A	+	0	0	0	.8	1.6	0	+	0	0	0	+	0	0	0
	VIII C	+	+	±	0	.6	1.2	0	+	0	0	±	+	0	0	0
	XXII B	+	+	0	0	.7	1.6	0	0	+	r	+	0	0	0	+
Bacillus	III A	0	0	0	0	1.0	2.0	0	0	+	+	+	0	0	0	0
	II B	0	+	....	....	.8	1.5	+	0	0	+	0	+	0	0	0
	I D	+	0	0	0	1.5	3.2	0	0	+	+	0	0	0	0	0
	IX A	+	+	+	0	1.0	1.6	+	0	0	+	+	+	0	+	0
	XIV B, XVII A	+	+	0	+	.8	1.6	+	0	0	r	+	0	+	+	+
	III B	+	+*	0	+*	.8	1.5	+	0	0	+	+	0	+	0	+

*Gas. r = ring.

THE YEASTS.

For the classification of yeasts we did not find any convenient system and therefore made the groups according to morphology and physiology without naming them.

In isolating the yeasts from the original agar plates we made the distinction between the following four groups:

1. Round, smooth, glistening (surface colonies).
2. Small, star-shaped (below surface).
3. Large, dull, convex.
4. Pink.

From the agar plates the yeasts were isolated into broth, and after 1 or 2 days, plated in ordinary gelatin. The forms of the gelatin colonies of the first two groups were so different that it seemed at first possible to classify the yeasts according to the shape of the colonies. We could distinguish the perfectly round type, the irregular type with granulated edges, and two branching types, one with filamentous branches and another with thick, finger-shaped branches. But these types were not strictly limited, some of the yeast colonies were links between different types, and a few others gave two different types of colonies on the same gelatin plate.

We had more success with the morphology of the yeasts determined from the slant lactose agar cultures. It was possible to recognize a type of a small, irregular elliptic or oval yeast, and to place about 100 of the cultures in this one group. There were slight differences between some cultures, but in general there was enough similarity to allow of this. This group is called the *small irregular yeast.* Besides this type, there was another more distinct kind of yeast with perfectly round cells, all of which seemed to belong to the same species.

The *large, dull, convex* yeasts were all rapid liquefiers, and the morphology was very much the same in all cultures. The pink *yeasts* did not show remarkable differences. They were always found in such small numbers that we did not pay very much attention to them, since they were either contaminations of the plates, or of the butter, and certainly had nothing to do with the keeping quality of the butter.

After we had grouped the yeasts as far as possible in the above-mentioned types, there were more than forty cultures left; these were transferred in wort and some of them caused a fermentation of maltose, the rest were transferred onto wort gelatin, ordinary gelatin, and finally on slant agar and most of them could now be identified as small irregular yeasts. Only a very few were left as different from all previously described forms.

The *large, dull, convex* yeast colonies on the original agar plates all belonged to the same kind of yeast, but the *round, smooth, glistening,* and the *small, star-shaped* colonies belong to three different groups, the *small irregular,* the *perfectly round,* and the *maltose fermenting* yeasts. For this reason, the counts of these types are certainly not exact, because in many cases two different kinds are counted as only one species, e. g., Xa, XVIa_3, XXIIa_2, a_3, but since it was impossible to see any difference in the form of agar colonies we must be satisfied with these results of probability.

All of our yeasts were non-spore-producers. They certainly do not belong to the genus Saccharomyces. We classify the yeasts as follows:

- White Yeasts.—Liquefying.
    - Rapidly liquefying.
    - Slowly liquefying.
        - Pure white.
        - Cream white.
  - Non-liquefying.
    - Small irregular.
    - Perfectly round.
    - Maltose fermenting.
- Pink Yeasts.

The *rapidly liquefying yeast* is a scum yeast with large cells, Usually the larger ones are elliptic, 4 x 6μ, 5 x 6μ, sometimes to 6 x 10μ; the smaller are round and 3 x 3μ to 4 x 4μ. The agar streak culture is dull. After 3 weeks crystals appear in the nutrient agar and lactose agar. The agar turns light brown. The gelatin is rapidly liquefied. After one day the liquefaction is usually saccate and later becomes stratiform. Milk is curded after 2 or 3 days and rapidly digested at neutral reaction. On other liquid media, as broth, wort and so on, a dry scum is formed, the liquid is turbid and there is much sediment. There were, in all, 26 cultures of this kind isolated.

The *white, slowly liquefying yeast* resembles somewhat the rapidly liquefying kind. It is only found twice in two different tubs of butter sample XVIII. The cells are almost rectangular and very large, 4 x 8–4 x 16μ, a few smaller ones, 4 x 5 or 4 x 6μ, are elliptic; the cells are mostly granulated and have no vacuoles. They begin to liquefy gelatin slowly after 2 days of growth. The agar culture is not different from that of the rapidly liquefying yeast. Milk is curded and peptonized at neutral reaction.

The *cream white, slowly liquefying yeast* is found once in sample XIII, and once in XX. It has very regular elliptical cells 5 x 7μ in size. The growth on lactose agar is abundant. A yellowish slime is produced 2–3 mm. thick, spreading over the whole surface of the agar. Gelatin begins to become liquefied after 1–3 weeks. Milk shows no change.

The *small irregular yeast* is very different in size, the smallest cells are almost round and about 2μ in diameter, sometimes even smaller. The average cells are elliptical or oval and about 3 x 4μ in size. Some larger cells are usually, but not always found. Many of these cultures tend to produce elongated cells—sausage forms—which sometimes reach the length of 20 and 25μ; this tendency is usually a peculiarity of all the cultures of the same butter sample, and it seems that the yeasts of different dairies are different varieties of the same species. The agar streak culture is glistening white, and not characteristic. There are no crystals, and there is no difference between ordinary and lactose agar. In gelatin there is arborescent growth, but no liquefaction; in broth and wort, turbidity, a ring around the surface of the liquid, but no distinct scum. Milk stays neutral or turns very slightly alkaline.

The *perfectly round yeast* has regular cells of 4–5μ diameter. Its nutrient agar streak culture has a slight iridescence like mother-of-pearl; it has also parallel lines across the streak and on lactose agar, abundant growth over the whole surface (except XIXf). There are crystals in ordinary agar, not in lactose agar. The gelatin stab is not arborescent, but filiform or beaded. Wort is clear, with an abundant flocculent sediment and a very prominent pronounced ring around the surface. We found this round yeast in 20 different butter samples, 15 of these samples came from the cold storage *a*, which was always kept above the freezing point. Only 5 of the yeasts came from the other cold storage. This yeast therefore seems to prefer the warmer storage, and is able to outgrow the small irregular type.

The *maltose fermenting yeasts* belong certainly to different species. The yeasts of the lots IX and XIV ferment maltose only, and are not at all influenced by lactose. The yeast X ferments maltose only, but grows abundantly in the presence of lactose. It also liquefies slowly after 20 or 30 days. The other five yeasts ferment maltose as well as lactose—they are the three yeasts of XI and one each of XIV and XXII. Four of these are small elliptic or round yeasts, 3 x 4μ and 4 x 5μ in size. Yeast XIb is larger, 4 x 5–5 x 6μ, and has many granules. Yeast X has elliptic cells 5 x 6μ and larger, mixed with small round cells 3 x 3μ. Yeast IX is somewhat larger, 4 x 6–4 x 8μ is the predominant size. Yeast XIV is perfectly irregular with many sausage forms.

STREPTOTHRIX.

The micro-organisms which were named Streptothrix may perhaps be something different. Migula says that most of the organisms described as Streptothrix do not belong to this family at all. We believe, however, that our germs are identical with the Streptothrix found by Reinmann and Jensen in butter, and therefore used the same name. Besides the one quite frequent white species, which liquefied gelatin and curded and digested milk with neutral reaction very rapidly, we found twice a chalky-white species and three times a brown species. In our tables we did not make a distinction between these three kinds.

The three *molds* which were found quite frequently were Oidium lactis, Penicillium glaucum, Aspergillus glaucus.

ANÆROBIC ORGANISMS.

Fifty-six cultures were isolated from the plates kept in Novy jars under anærobic conditions. These were transferred from the isolation plates to duplicate slant agar tubes, one of which, in each case was placed in an atmosphere of hydrogen while the other was left in the air. In no single instance was an organism found which failed to grow well under ærobic conditions. No attempt was made to isolate anærobic bacteria after the first examination.

THE ORGANISMS FROM WHEY AGAR.

Duplicates of all plates made in the first examination were run in whey agar made as described under *methods*. These plates had been expected to give higher counts than the standard agar plates, but actually gave only half the numbers, or even less for the ordinary lactic acid organisms. The other bacteria did not develop so well on these plates. So far as the lactic bacteria are concerned, the results do not agree with some of the earlier work in this laboratory and it is, therefore, being continued.

LACTIC ACID BACTERIA.

The table X gives the lactic bacteria in percentages of the total number found in fresh butter. The averages of these show that the decrease is fairly regular; in November we had still about 14–17% of the original number alive; in February there were only 6% left. Though the averages agree very nicely, in single samples there are often great variations; for instance, IV and XXI with the extraordinary high numbers, and II, VIII and X with their rapid decrease.

The decrease of bacteria seems to be clearly connected with the amount of salt, or rather, with the concentration of brine, in the butter. In arranging the samples according to the brine concentration in three groups we get the following averages:

BRINE CONCENTRATION LACTICS		IN PER CENTS OF ORIGINAL NUMBER.					
Limits.	Average.	b	c	d	e	f	g
8.3—10.8%	9.4%	7.9	7.8	17.3	2.4	3.6	3.3
13.7—20.0%	16.8%	16.3	17.0	7.5	6.7	5.7	5.9
20.1—31.3%	25.1%	23.5	20.0	19.8	8.6	8.9	9.1

The salt is certainly not the only reason for the decrease of bacteria, for we have seen very striking exceptions: e. g., Sample XXI with a brine concentration of only 10.8%, but a very high percentage of lactics.

The better keeping of bacteria in the high salted samples can be explained in two different ways. Probably the low salted butter was frozen in the cold storage and the bacteria could no longer multiply, but died slowly as was found in ice-milk by Bischoff, whereas, in the high salted butter the brine is not frozen and the bacteria have a chance for a very slow development.

It may be possible, however, that the brine surrounded by fat and distributed in small drops, does not solidify in the cold storages. The bacteria of the low salted butters develop more rapidly and of course decrease earlier than the slower growing germs of the high salted butter. This last explanation certainly passes for the samples in the college storage. On the other hand, the former explanation seems to be more in accordance with the work of Gray; as shown by his scores the low salted butter kept better in cold storage while high salted butter kept better when packed in cans and kept at varying, ordinary temperatures.

TABLE X.

Occurrence of Typical Lactic Bacteria.

Sample	Fresh	November				February			
	a	a$_2$	b	c	d	a$_3$	e	f	g
I	1,200,000	0	144,000	....	....	0	82,000	....	....
III	24,650,000	0	1,200,000	....	....	0	42,000	....	....
V	3,200,000	0	90,000	....	....	0	22,000	....	....
IX	1,900,000	0	480,000	460,000	380,000	0	5,000	14,000	10,000
II	26,000,000	0	750,000	390,000	750,000	3,500	300,000	415,000	650,000
IV	3,140,000	0	1,400,000	776,000	1,300,000	0	655,000	540,000	751,000
VI	10,000,000	0	1,700,000	1,600,000	570,000	0	520,000	600,000	130,000
VIII	550,000	0	30,000	20,000	17,000	300	6,000	6,000	5,000
X	3,000,000	0	72,000	88,000	10,000	0	5,000	8,000	3,000
XI	20,750,000	3,000	1,000,000	2,000,000	1,500,000	1,750	212,500	760,000	263,000
XIII	15,000,000	6,000	3,000,000	2,500,000	1,650,000	3,000	1,000,000	1,725,000	1,000,000
XIV	3,000,000	1,000	145,000	285,000	185,000	700	75,000	82,500	22,500
XV	7,650,000	3,000	765,000	470,000	520,000	2,000	125,000	350,000	170,000
XVI	3,600,000	4,000	762,000	685,000	575,000	1,400	325,000	325,000	225,000
XVII	25,000,000	25,000	1,525,000	1,575,000	1,650,000	45,000	1,125,000	2,000,000	1,000,000
XVIII	14,000,000	4,000	4,200,000	4,300,000	4,000,000	10,000	1,000,000	1,200,000	1,750,000
XIX	4,500,000	3,000	570,000	850,000	750,000	0	50,000	300,000	100,000
XX	1,500,000	1,000	200,000	200,000	200,000	300	100,000	55,000	65,000
XXI	3,000,000	0	460,000	290,000	1,800,000	0	150,000	50,000	230,000
XXII	6,000,000	10,000	2,630,000	3,190,000	290,000	6,300	1,300,000	625,000	1,250,000
Average	9,168,000	....	1,200,000	1,201,000	1,050,000	....	435,000	565,000	475,000

TABLE XI.

Lactic Bacteria in Per cents of their Original Number.

Sample	November				February		
	a$_2$	b	c	d	e	f	g
I	0	12.0	....	....	6.8	....	....
III	0	4.9	....	....	1.7	....	....
V	0	2.8	....	....	0.7	....	....
IX	0	25.3	24.2	20.0	0.25	0.73	0.53
II	0	2.9	1.5	2.9	1.2	1.6	2.5
IV	0	44.6	24.7	41.4	20.8	17.2	23.9
VI	0	17.0	16.0	5.7	5.2	6.0	1.3
VIII	0	5.5	3.6	3.1	1.1	1.1	.9
X	0	2.4	2.9	0.3	0.2	0.3	0.1
XI	0.01	4.8	9.6	7.2	1.0	3.6	1.3
XIII	0.04	20.0	16.6	11.0	6.6	11.5	6.6
XIV	0.03	4.8	9.5	6.2	2.5	2.7	.8
XV	0.04	10.0	6.1	6.8	1.6	4.6	2.2
XVI	0.01	21.2	19.0	16.0	9.0	9.0	6.3
XVII	0.01	6.1	6.3	6.6	4.5	8.0	4.0
XVIII	0.03	30.0	30.7	28.6	7.1	8.6	12.5
XIX	0.06	12.6	18.8	16.6	1.1	6.6	2.2
XX	0.06	13.3	13.3	13.3	6.6	3.6	4.3
XXI	0	15.3	9.6	60.0	5.0	1.6	7.6
XXII	0.16	44.0	53.2	4.8	21.6	10.4	20.8
Average	0.03	16.9	15.1	14.4	5.9	6.0	5.1

TABLE XII.

Occurrence of all Except Typical Lactic Bacteria.

Sample	Fresh	November				February			
	a	a_2	b	c	d	a_3	e	f	g
I	14,000	300	9,000	....	....	(........)	1,700	....	....
III	136,100	(........)	43,000	....	....	(100)	6,300	....	....
V	602,200	(........)	7,000	....	....	(700)	2,200	....	....
IX	77,000	0	3,000	11,000	3,000	0	4,000	6,100	5,100
II	46,000	(1,000)	4,000	28,000	3,200	1,400	9,300	5,500	5,000
IV	63,000	(........)	14,000	12,000	24,000	(100)	12,000	13,300	12,200
VI	25,000	(........)	3,000	6,000	4,000	(........)	3,800	7,200	1,500
VIII	5,000	(........)	400	1,500	500	(800)	3,000	2,400	2,700
X	2,000	(........)	1,000	2,000	100	0	5,400	3,300	1,000
XI	70,000	2,100	0	1,100	0	1,100	(6,000)	(206,000)	0
XIII	12,000	0	4,100	1,000	3,000	3,000	3,500	5,000	2,400
XIV	19,000	600	3,400	3,000	1,400	1,400	3,500	2,800	4,600
XV	20,000	0	200	3,000	2,000	1,000	3,800	1,600	3,000
XVI	12,000	700	1,100	7,600	2,000	300	6,100	6,000	7,500
XVII	50,000	0	3,000	4,000	2,300	3,000	6,900	5,300	5,100
XVIII	110,000	1,600	3,100	4,300	8,000	700	5,000	5,300	6,000
XIX	26,000	3,000	6,000	3,100	3,000	13,000	5,000	13,000	1,000
XX	10,000	0	2,000	2,500	6,000	200	1,000	500	1,000
XXI	104,000	0	22,000	36,000	4,000	0	26,000	42,100	24,000
XXII	4,000	0	2,000	3,500	3,000	1,900	1,300	1,000	1,400
Average	36,000	....	4,600	7,400	4,400	....	6,400	7,200	5,200
Per cents of fresh butter	....	....	12.9%	20.6%	12.2%	....	17.8%	20.0%	15.0%

TABLE XIII.

Occurrence of Liquefying Bacteria.

Sample	a	a_2	b	c	d	a_3	e	f	g
I	7,000	100	2,000	....	....	(........)	500	....	....
III	127,100	(........)	7,000	....	....	0	2,800	....	....
V	601,200	100	2,000	....	....	700	0	....	....
IX	77,000	0	2,000	10,000	2,000	0	4,000	5,100	5,100
II	19,000	100	4,000	21,000	3,200	0	8,600	5,500	15,100
IV	53,000	(........)	14,000	12,000	2,000	100	0	13,000	0
VI	9,000	(........)	0	2,000	2,000	100	300	2,200	0
VIII	3,000	(........)	100	100	0	800	2,900	2,400	700
X	2,000	0	0	1,000	0	0	5,400	2,500	1,000
XI	30,000	2,100	0	0	0	1,100	0	(206,000)	0
XIII	5,000	0	2,100	1,000	1,000	0	3,500	4,400	2,100
XIV	6,000	200	2,400	2,000	1,400	400	2,400	2,800	4,600
XV	4,000	0	0	3,000	2,000	1,000	3,800	1,600	3,000
XVI	8,000	700	1,000	7,000	2,000	300	5,000	6,000	4,500
XVII	2,000	0	3,000	1,000	2,300	3,000	4,900	5,300	3,100
XVIII	90,000	1,600	3,000	3,300	8,000	0	3,000	5,300	5,000
XIX	3,000	3,000	0	3,000	0	12,000	5,000	13,000	1,000
XX	10,000	0	0	1,000	1,000	0	1,000	500	1,000
XXI	6,000	0	21,000	2,000	1,000	0	26,000	42,100	24,000
XXII	3,000	0	0		0	400	300	1,000	1,400
Average	15,800	480	3,160	3,710	1,620	1,600	4,500	6,700	4,160
Per cents of fresh butter	....	3.0%	19.7%	23.2%	10.1%	10.0%	28.1%	41.9%	26.0%

The percentage decrease of bacteria has no relation to the absolute number in fresh butter. The absolute number of lactic acid bacteria in fresh or old butter has nothing to do with the scores. The percentage decrease also did not agree with the scores. In the warmer storage a_2 and a_3 the lactics have practically disappeared; in some of the samples the destruction was so complete that even if 1-100 cc. of the butter fat were transferred to sterile milk there was no acid produced.

The influence of salting has never been the subject of a very extensive bacteriological study. Since the salt of the butter is only dissolved in the water of the butter, we have quite strong salt solutions. A butter with 2% of salt and 15% of water has a brine concentration of 13.4%. This solution plasmolyzes most of the bacteria, but not all. We know that the effect of plasmolysis on bacteria is not very pernicious; it prevents their multiplication, but, for instance, not the motility. Besides that, several kinds cannot be plasmolyzed at all, as e. g., *Bac. subtilis and B. anthracis* (Lafar I, p. 63). We know other bacteria that are able to multiply readily in concentrated salt solutions, for instance the bacteria of the salted fish; Levandowsky isolated several kinds from saturated salt solutions. Wehmers Salt Yeast was only retarded in its growth by adding 15% salt (Lafar IV, p. 290). Gorini (Rev. Gen. du Lait IV, 1904, 73) found a gas-producing coccus which multiplied rapidly in a 20% brine solution. This agrees with the experience of the dairymen who used strong brine for cleaning or preserving the tubing of the milking machines. It was quite impossible to prevent growth by application of salt only, no matter how strong the solutions were.

These facts explain why even high salted butter does not keep indefinitely. But there is no doubt, of course, that salt is a very valuable factor for keeping butter for some time, because it certainly retards the growth of all micro-organisms.

NON-LACTICS AND LIQUEFIERS.

The decrease of the non-lactic bacteria (Table XII) is in November about the same as that of the lactics; in February, however, there is no further decrease, but apparently a slight increase of non-lactic bacteria. Table XIII shows that this increase is mostly due to the liquefying bacteria. This result is certainly interesting, since it is an average result from 16 different samples, and makes it more probable that the rancidity of cold storage butter is connected with a decomposition of protein substances. This increased number of liquefiers is mostly due to *Bacterium lactis lobatum, Bact. l. album, Bact. l. Gorinii* and *Bacillus l. cochleatus.* The liquefying cocci have no pronounced increase.

THE FREQUENCY OF THE MICRO-ORGANISMS.

We were somewhat disappointed in our work when we saw that there were no micro-organisms regularly present in butter except the lactic acid bacteria.

In dividing all bacteria in the 6 morphological groups and subd v ding into liquefiers and non-liquefiers, we get the following table:

	Non-liquefiers		Liquefiers	
	Number of cultures	Number of species	Number of cultures	Number of species
Cocci	43	5	106	5
Bacteria	73	15	57	18
Bacilli	14	5	66	22
Streptothrix	0	0	46	3
Yeasts	167	4	30	3
Molds	0	0	120	5
Total non-lactics	297	29	425	56
Lactics	157	2	....	....
Total	454	31	425	56

From the 879 isolated pure cultures, 454 were non-liquefiers, 425 liquefiers. A total of 87 different species of organisms were found in butter, most of them were found only once or twice.

If we arrange all our organisms according to their frequency, we get the following result:

1	Lactic acid bacteria	157	times in	20	lots.
2	Small irregular yeast	127	"	20	"
3	Micrococcus lactis varians (71+13)	84	"	16	"
4	Streptothrix	46	"	18	"
5	Oidium lactis	44	"	14	"
6	Penicillium glaucum	44	"	14	"
7	Bacterium lactis Connii	38	"	16	"
8	Aspergillus glaucus	30	"	16	"
9	Micrococcus lactis aureus	27	"	10	"
10	Rapidly liquefying yeast	26	"	11	"
11	Bacillus lactis cochleatus	18	"	6	"
12	Pink yeast	17	"	7	"
13	Round yeast	16	"	10	"
14	Micrococcus lactis albidus	16	"	11	"
15	Bacterium lactis lobatum	11	"	3	"
16	Bacterium lactis album	9	"	7	"
17	Bacterium lactis Gorinii	9	"	4	"
18	Maltose yeast	9	"	4	"
19	Bacillus lactis Pruchii	8	"	3	"
20	kinds with	736	cultures	20	lots.

Besides these more frequent organisms, we found

35 different kinds	1	times	35	cultures
14 " "	2	"	28	"
3 " "	3	"	9	"
7 " "	4	"	28	"
5 " "	5	"	25	"
3 " "	6	"	18	"
67 " "			143	"
20 " "			736	"
87 " "			879	"

TABLE XIV.—*Occurrence of the more frequent organisms in the different storages.*

Organisms.	I	III	V	IX	II	IV	VI	VIII	X	XI
Micrococcus lactis varians	b_2	a_1 b_3	a_1	b d f g	b d e f g	a_1 c f			a_1 e g	
varians O		a_1		a_1	a_1	a_1	a_1			
aureus	b_3	b_2				b	a_1 b c d e f g			
albidus	a_3		a_1	a_1	d	b d	a_2 d	a_1	a_1 c	
Bacterium lactis Connii	a_2 b_2	b_2 a_3 b_3	b_2 b_3	c		f g	a_1 b d	a_1		a_1 c
lobatum										
album	b_3	b_2					c a_3 e f			a_3
Gorinii										f
Bacillus lactis cochleatus				a_1 g	a_1 g			a_2 a_3 g		a_1 a_2 a_3 f
Pruchii			a_2 a_3						a_1 c e f g	
Small irregular yeast	a_1 b_2 b_3	a_2 b_3	b_3	a_1 b c e f g	a_1 a_2 b c d a_3 e f g	a_1 a_2 b c d a_3 e f g	a_2 b c d e f g	b c e f g	a_2 b c d a_3 e f g	a_2 d e g
Liquefying yeast	a_1			a_1 b c e f g	c		b		d f	c e f g
Pink yeast	a_2 b_2			a_1 b d a_3 g		c	c g			
Round yeast	a_2			a_2 a_3		f			c	
Streptothrix	a_2	a_2 b_2 b_3	a_2 b_3	a_1 a_2 b d a_3	c d e f g	f g	a_1 d e f g	a_1 d f	a_1 d	d
Oidium	a_1 b_2	a_1	a_1	a_1 a_2 b c d a_3 e g	a_2	b			a_3 g	a_1 b c d e f g
Penicillium	a_2 b_2	a_2	a_2	a_1 d	a_1 b	a_1 a_2 c a_3	a_2 c	a_1 a_2 c a_3	d f g	a_3
Aspergillus	a_2	a_2	a_2 b_2	a_1 d	a_1 a_2 b	d	c d a_3	c		a_1 a_2

TABLE XIV.—CONCLUDED.

Organisms.	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII
Micrococcus lactis varians	b c d e f g	a_1 a_2 b c d a_3 e f g	a_1 c d a_3 e g	a_1 a_2 b c d a_3 e f g	a_1 b a_3 f g	a_1 a_2 b c d f g	c f	e f g	d e f g	f
varians O		a_1	a_1	a_1		a_1 c	a_1	a_1 c		
aureus					c e	b a_3 e	a_1 b d	b d a_3	a_1 b c	c d e
albidus	g						a_1 a_3		b c	
Bacterium lactis Connii	f	a_1 b c e	a_1 b	a_1 b c	a_1 c g	c g	b c		c d	b c d
lobatum				a_1 f	a_1 b c e f g		a_2 e f			
album							e		a_1	
Gorinii			c d e f g			e f			f	
Bacillus lactis cochleatus	f g					d e f				a_3 e
Pruchii								d		
Small irregular yeast	a_1 b c d a_3 e f g	a_2 c d a_3 e f g	a_2 b c d a_3 e f g	a_2 b c d e f g	a_2 b c d e f g	a_2 b c d a_3 e f g	b c d a_3 e f g	a_2 b c d a_3 e f g	a_2 b d a_3 e f g	b c d e f
Liquefying yeast	e f g	c d	a_1 b d g		a_3		g			c
Pink yeast						a_2 e g	d g			a_1 c
Round yeast	a_2 a_3 g			a_3	a_3		a_2 d f	a_3		a_2 a_3
Streptothrix	c f		a_1 d g	a_1 c	a_1 d		a_1 c	d e	a_1 c	c d
Oidium	a_1 a_2 b c d a_3 e f g	a_2		a_1		a_1			a_1 a_2 b c a_3 e f g	d
Penicillium	a_1 d a_3	a_2	a_2 a_3	a_1 a_2 d	a_1 a_2	a_1 a_2	a_1 a_2 a_3		a_1 a_2 d a_3	a_1 a_2 b
Aspergillus		a_2 a_3	a_2		a_1	a_1 c d	a_1	a_1 b	a_1 b	b c a_3

TABLE XV.—*Frequency in different storages.*

Organisms.	a_1	a_2	b	c	d	a_3	e	f	g	Total
Micrococcus lactis varians	9	3	8	7	8	4	9	12	11	71
varians O	11	0	0	2	0	0	0	0	0	13
aureus	5	0	8	4	3	2	5	1	1	27
albidus	5	1	2	1	3	2	1	0	1	16
Bacterium lactis Connii	7	1	9	9	3	1	3	2	3	38
lobatum	2	1	1	1	0	0	2	3	1	11
album	1	0	1	1	0	2	3	1	0	9
Gorinii	0	0	0	1	1	0	2	4	1	9
Bacillus lactis cochleatus	3	2	0	0	1	3	2	3	4	18
Pruchii	1	1	0	1	1	1	1	1	1	8
Small irregular yeast	5	13	16	16	15	10	20	16	16	127
Liquefying yeast	3	0	3	5	3	1	3	4	5	28
Pink yeast	2	2	3	3	3	2	0	0	3	18
Round yeast	0	5	0	1	1	6	0	2	1	16
Streptothrix	9	4	2	6	10	1	5	5	4	46
Oidium	9	4	7	4	4	4	4	3	5	44
Penicillium	10	15	2	4	5	7	0	1	1	44
Aspergillus	8	7	5	3	5	2	0	0	0	30

OCCURRENCE IN DIFFERENT STORAGES.

Table XV shows the occurrence of the more frequent organisms in the different storages. *Micrococcus lactis varians* decreased in the warmer storages a_2 and a_3, but in the colder storages it kept its frequency. The orange variety, however, disappeared almost entirely. Either it was killed or the long storing made it more similar to the real M. l. varians. We are inclined to the former explanation, since it was only with considerable difficulty that we were able to keep these cultures alive in the laboratory. The *Micrococcus lactis aureus* grows apparently best in storage *c-e*. Whether this is only accidental or due to a special quality of the storage, we cannot say. *M. l. albidus* is rather regularly distributed. *Bacterium lactis Connii*, rather frequent in the colder storages in November, died after this, and was not frequent in February. Probably the bacteria died from their own decomposition products. In the warmer storage, *a*, they were already dead in November, also in storage *d*, which was unsatisfactory in the beginning; in the colder storages, it grew more slowly and in November it was probably at the limit of its development, which naturally was followed by a decrease. *Bact. l. lobatum* is not especially affected by the cold. *Bact. l. Gorinii* appears only in the February butters, just as does *Bacillus l. cochleatus*. This may be caused by a very slow development, but it may be that they are very resistant, and though they did not increase in number, were found in the last investigation, because most of the other bacteria had died and they could be more easily detected on the agar plates. *Bacillus l. Pruchii* is the most regular germ, since it occurs just once in each storage. The *small irregular yeast* is the most interesting organism because of its frequency and its high number, which goes up to several millions in some samples. It behaves about the same as *Bact. l. Connii.* It is comparatively seldom found in the fresh butter (perhaps its colonies on the agar plate could not be distinguished easily from the more frequent lactic colonies), it develops in the storages rapidly, in spite of the cold and salt, and we find it in 127 out of 168 tubs. The February examination shows a decrease in number, but not in frequency. The *liquefying yeast* is not so often found in the warm storage, but keeps its frequency in the colder ones. The *round yeast,* on the contrary, grows almost exclusively on the samples *a.* The *pink yeast* disappeared in the coldest storages in February. Its number was always so small that we did not pay any attention to it.

The distribution of *Streptothrix* is not very regular, probably because it is impossible to make exact counts of these hard, tough organisms, which stick together. This is to a certain extent true also with the molds, but our tables show very plainly the slow decrease of *Oidium* in comparison with the fresh butter and more distinctly of the *Aspergillus* and *Penicillium. Penicillium,* and to a certain degree, *Aspergillus,* developed to a greater extent in the warm storages.

COMPARISONS OF OUR MICRO-ORGANISMS WITH THOSE FOUND BY OTHER AUTHORS.

Comparing the micro-organisms which we found with those isolated by other investigators from fresh and old butter the results disagree very decidedly. Almost all other investigators found several species of micro-organisms regularly present in butter, whereas we have besides the lactics the only one, *small, irregular yeast,* which was almost always present; the *Micrococcus lactis varians* was only in half of our samples and the rest occurred even less frequently. This difference is mostly due to the different temperature. The temperature below the freezing point makes the conditions for development very unfavorable, whereas the room temperature which the other investigators used for keeping their samples gives very good conditions for the multiplication of germs. The higher average salt content of American butter, compared with that of European origin, helps also to decrease the number and the kinds of organisms. Besides that, the butter of those investigators became rancid within a few weeks, whereas, on account of the entirely different conditions, we did not begin our first examination until after the tubs had been in storage for at least five months. It must be considered also, that we had a greater variety of very different samples than most of the other authors, and therefore there was a greater probability that some of them would lack species which were found frequently in many other samples. Since the conditions for the fresh butter were quite different, we cannot be surprised to find the difference still more pronounced in the old butter, for the chemical changes were different, the acidity not increased and the butter altered in some other way.

Let us compare now our bacteria with those found by other investigators in ordinary fresh and rancid butter.

Krueger found in a sample of cheesy butter *Micrococcus acidi lactis, Bacillus fluorescens non-liquefaciens,* 2 species of *Saccharomyces, Oidium lactis, Lactic acid bacteria.*

These organisms, except the two kinds of *Saccharomyces,* were found also in some of our samples, *M. acidi lactis* probably being identical with *M. lactis albidus.*

Lafar isolated from sweet cream butter from a creamery in Munich regularly *Bacterium butyri colloideum, Bacillus fluorescens liquefaciens,* frequently several *wild yeasts, Lactic acid bacteria, Bacterium lactis ærogenes.* He never found molds in butter, not even in old, rancid samples. *Bacterium butyri colloideum* could not be identified. It is worth while mentioning that its activity was not very much influenced by an addition of 10% salt and that it stood a temperature of —10 to —15° C. without being much affected. The fluorescent bacillus was more sensitive against salt and cold.

The bacteria which v. Klecki isolated from rancid butter could not be identified with any of our organisms. Hellstroem reports that in old butter he found usually nothing but *Oidium lactis* and several species of *Saccharomyces.* The only bacterium he detected was *Bacillus microbutyricus,* which is, in many respects, similar to the *Bacterium lactis Isignii* Conn, especially in digesting milk without liquefying gelatin. It never occurred in our butter.

Reinmann gives quite a number of organisms in butter, but he says nothing about their frequency.

Micrococcus acidi lactici
Sarcina lutea
Bacillus acidi lactici
" *helvolum*
" *coli and varieties*
" *mesentericus vulgatus*
" *butyricus* Hueppe
" " Botkin

Bacillus fluor. liquef.
" *Proteus*
Streptothrix alba
Oidium lactis
Two *white yeasts*
Pink yeast
Mucor

Of these 16 organisms we found only 7 in our samples, namely, *Micrococcus* and *Bacterium acidi lactici, Bacillus fluorescens liquef., Streptothrix, Oidium, Pink Yeast* and *Mucor*; perhaps one of his white yeasts which are not described are identical with one of ours.

Jensen found in his frequently mentioned work

	In fresh butter	In rancid butter
always	*Lactic acid bacteria* *Bacillus ærogenes* and similar species *Microc. acidi lactici* *Bacillus fluoresc. liquef.*	*Oidium lactis* *Cladosporium butyri* *Mycoderma* species *Lactose yeasts* *Lactic acid bacilli*
often	The germs of rancid butter *Bacillus prodigiosus* *Bacillus microbutyricus liquefaciens.*	The germs of fresh butter *Bacillus microbutyricus* Hellstroem *Penicillium glaucum*

We never found, in fresh butter, *Bacillus ærogenes* and *prodigiosus*; *Bacillus microbutyricus liquefaciens* is not described; we never found, in rancid butter, the *long lactic acid bacilli* nor *Bacillus microbutyricus* Hellstroem. *Cladosporium butyri* might have been present, though we did not find it, because its colonies are very much like *Oidium* colonies.

Reitz found, in all samples investigated from the Stuttgart butter, regularly the following organisms:

Bacterium lact. acidi
Staphyloc. pyogenes albus
Staphyloc. pyogenes aureus
Streptococcus pyogenes
Micrococcus sulfureus
Most samples contained
Bacterium prodigiosum
" *coli*

Micrococcus roseus
Sarcina flava
Actinomyces
Saccharomyces rosaceus
Molds.

Micrococcus cerasinus

The butter in Stuttgart must have been of a very low quality, containing regularly 11 different species.

Staphylococcus pyogenes aureus and *albus* are identical with *Micrococcus lactis varians* and *albidus* Conn. Whether *Micrococcus sulfureus* and *Sarcina flava* are identical with some of our organisms cannot be decided because the description of Migula gives no data about their acid production in different sugars and their development in milk. *Streptococcus pyogenes, Bacterium coli* and *prodigiosum, Micrococcus roseus* and *cerasinus* are never found in our samples. The *Actinomyces* may be identical with one of our so-called *Streptothrix,* but since Reitz gives no description at all, it is not certain. The *Saccharomyces rosaceus* is probably a pink *Torula,* since red *Saccharomycetes* are never described. Rogers found in old, fishy butter, liquefying bacteria, mostly spore-producing kinds, and *Torula* yeasts, which perhaps belonged to different species; his very short description does not disagree with the description of our *small, irregular yeast.*

We intended also to identify our bacteria with those isolated by Pennington from cold stored milk; this was, however, impossible, because in the publications there is nothing given but the name, and the description in Chester is so incomplete that we could not compare the different bacteria. Pennington found only two species more frequently, namely *Bacillus formosus* 12 times and *Bacillus solitarius* 9 times. Besides this, there was *Bacillus cloacae* 4 times, *Bac. Raveneli* 3 times, 4 bacteria were found twice and 19 organisms only once. Therefore, we cannot speak of a characteristic flora in cold stored milk.

THE ORIGIN OF THE BACTERIA IN BUTTER.

The origin of the bacteria in butter is not always the same. Several kinds are the regular inhabitants of milk, as the lactic acid germs and the *Micrococcus lactis varians,* which was found most regularly in our butter samples. This germ is supposed to be one of the bacteria ordinarily found in the cow's udder (see p. 37). *Oidium lactis* is almost always present in milk. These organisms may be prevented by pasteurization of the cream before the ripening with a pure culture.

Other bacteria are derived from the wash water. *B. fluorescens liquefaciens* probably comes from this source. The Iowa Exp. Sta. (Bul. 71) and the Kansas Exp. Sta. (Bul. 138, p. 212) found a direct relation between the bacterial content of wash water and the keeping quality of butter. Lloyd (Journ. British Dairy Farmers' Assoc., 18, (1904), p. 136) uses twice pasteurized skimmed milk for washing.

Molds and yeasts are not in the cream in large quantities, though they are regular habitants of ordinary butter. Hastings (Wisc. Sta. Report, p. 107, 1906) found lactose fermenting yeasts in about ¼ of all butter samples. Will says in Lafar's Handbuch der Technischen Mykologie, Bd. 4, p. 285: "The Torulaceæ find lodgment in all kinds of organic substances and often develop there to a really surprising extent. Milk, butter and cheese give them favorable conditions. Their main habitats are the creameries and all kinds of fermentation industries, and the organisms are not only found in the raw material and in the products made from it in all the different stages, they are also in the air of all rooms, on the walls of the fermenting and storing rooms, as well as on the utensils, in perfectly enormous abundance." This might explain the large percentage of wild yeasts that we found in our samples to be the most regular micro-organism besides the lactic acid bacteria.

Esten's publications about the sources of bacteria in milk give a good review of the latest investigations in this question and bring out some new, interesting points.

THE INFLUENCE OF MICRO-ORGANISMS UPON BUTTER.

The most interesting result of our chemical analyses of butter is certainly the fact that samples which are scored rancid or even very rancid did not have the slightest increase of acidity. This seems to indicate that rancidity of cold storage butter is not connected with a hydrolysis of fat in the ordinary way, and for the same reason cannot depend upon decomposition products of glycerine. It seems improbable that fat should be decomposed in any other way, since we cannot conceive of an oxidation in the interior of a 60 lb. butter tub, and an anærobic decomposition is almost impossible because of the lack of oxygen in the fat molecule.

Our investigations for fat splitting organisms were made in the following way: We made litmus agar from sugar-free broth (standard methods, Jour. Inf. Dis. Supp. No. 1, p. 107) and added a few drops of pure butter fat to each agar tube. The fat agar was sterilized as usual and, after the last heating, shaken violently in order to distribute the fat through the whole medium and was slanted. If fat-splitting bacteria are inoculated on this litmus fat agar, the free fatty acids will turn the litmus red. Other decompositions, which might produce acids, can hardly be expected in this medium. By this method we found just four micro-organisms from fresh butter, namely *Oidium lactis*, a Bacterium and a Coccus, which were found only once, and the orange variety of *Micrococcus lactis varians*, but only one out of eleven had split fat. It is, however, easily possible that many other micro-organisms lost their fat-splitting qualities by the cultivation on fat-free media.

It is worth while mentioning that the four normal samples with high acidity, II, XI, XIII, and XXI, have a very high number of *Oidium lactis*. The fat-splitting qualities of this mold are well known. The rancidity of these samples might be due to the decomposition of fat. It is a question as to what causes the rancid taste in the other samples. If the fat is not decomposed, there can be nothing but the lactose or the proteids. The lactic acid might be decomposed into butyric acid or some other acid, but its proportion is always very small. Still, it does not need very much butyric acid to cause a very disagreeable taste. The lactose, however, in the amount present, is not very likely to be decomposed into substances with a pronounced odor and taste. Certainly the protein substances are most apt to give bad tasting and smelling compounds, and some investigations along this line are being carried on in this laboratory; so far, however, without positive results.

The comparison of the scores of the samples with and without *Bact. lactis Connii*, *Bact. l. cochleatus*, *Oidium lactis*, and the liquefying yeast did not give any decided results. The samples are too different in their production to allow final conclusions. The most proper way of testing the influence of these organisms upon butter is the churning of sterile cream with pure cultures and mixed cultures as Jensen did.

We made several series of butters in this way, but almost all of them had contaminations of bacteria or molds. These experiments will be repeated again, though it seems exceedingly difficult to get a product which can be called butter, free from contamination.

THE DEVELOPMENT OF SOME BUTTER BACTERIA AT A LOW TEMPERATURE.

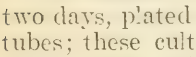
In the presence of mixed cultures, temperature is such an important factor that special attention has been given to it in some work which has been carried on at this station during the past year. In attempting to discover the nature of the changes which take place in butter stored at a low temperature for a considerable period of time, the initial content of micro-organisms in the butter—bacteria, yeasts and molds—capable of developing under standard laboratory conditions was at first determined. At the same time and from the same dilutions other plates were made, using whey gelatin prepared according to the method of Conn, (Bacteria in Milk and its Products, 1903, p. 270) and incubating in one of the cold storage rooms where a temperature of 4°–5° C. was maintained. Whey gelatin was used as it was thought at that time that this medium was one which would allow the development of the maximum number of organisms. Subsequent work has not entirely substantiated this view.

It was at first intended to watch the plates carefully and to count and isolate all micro-organisms which might develop, at a time sufficiently early to prevent disastrous liquefaction of the gelatin. It was found, on observation, that no serious liquefaction took place in 30 days, and all plates were, therefore, held and counted at the end of this rather long period.

The isolated micro-organisms were allowed to develop in broth for about two days, plated out on gelatin and isolated from these plates to slant agar tubes; these cultures being compared with the descriptions of the original colonies from which they were first isolated. Sub-cultures were then run in broth, gelatin, milk, potato, 1% dextrose, lactose and saccharose broth in fermentation tubes, and in Dunham's solution for indol. Full descriptions of all cultural characteristics were preserved.

As shown by the tables, the counts of the plates held at the low temperature are very much lower than the standard counts, but, on the other hand, they are much higher than had been anticipated. Typical lactic organisms (*Bact lactis acidi*) developed in numbers equal to about one-third of the number developing normally. Other microbes did not, as a rule, fare so well but were observed in considerable numbers, the acid producers—both liquefiers and non-liquefiers—appearing in rather larger numbers, relatively, than those not splitting the sugars. This may be due to their greater resistance to cold or to their greater inhibition in the standard plates.

Most of the yeasts, both non-liquefying and liquefying, found in the standard plates, were also met with in the low temperature plates, though somewhat less numerous. One variety often gave rise to a form of colony not often found in this work. The colony became first umbonate; later this projection extended vertically to some distance forming what might almost be called a stem, which sometimes bent over and touched the surface of the gelatin outside the base of the colony.



Aside from the cultural characteristics mentioned, the work shows that a large number of the micro-organisms commonly found in butter are capable not only of remaining alive, but of growing and developing at a comparatively low temperature when provided with a suitable nutrient pabulum and protected from inhibitive substances. The identification of these organisms follows.

CLASSIFICATION OF BACTERIA DEVELOPING AT A LOW TEMPERATURE

COCCACEÆ.

- *Cocci.*
  - Non-liquefying.
    - Non-acid.
      - Non-chrom. (IX. F, XVII. E.) Streptococcus versicolor.
  - Liquefying.
    - Acid. D. L. S.
      - Non-chrom. (XIV. E, G,) Micrococcus lactis albidus.
      - Orange-Yellow. (VIII. C, XIV. B, XVI. B. D.) M. l. varians.
    - Acid. Dext. only.
      - Non-chrom. (XVIII. B.) M. l. albidus, Var. C.
      - Orange. (VIII. D.) M. l. varians O.
    - Non-acid.
      - Non-chrom. (X. F.) M. l. albus.

BACILLACEÆ.

- *Bacteria.*
  - Non-liquefying.
    - Acid. D. and S.
      - Yellow. (XVII. C, XIX. B, D.) Bact. l. aureum, Var. A.
  - Liquefying.
    - Acid. Dextrose.
      - Green fluorescence. (X. C, XI. B.) Bact. l. fluorescens.
    - Non-acid.
      - Non-chrom. (VIII. B, X. A, XIV. F.) Bact. l. album.
      - Brown-Orange. (XI. E.) Bact. l. luteum(?).
- *Bacilli.*
  - Non-liquefying.
    - Acid. D. and L.
      - Non-chrom. (XI. C, XIX. E.) B. lactis sulcatus(?).
  - Liquefying.
    - Acid. D. and S.
      - Non-chrom. (XV. B.) B. l. cochleatus(?).
    - Non-acid.
      - Yellow. (X. D, XVI. C.) B. l. citronus(?).
      - Orange. (IX. H.) Ps. lactis anana(?).

The following table shows the number of the various organisms developing colonies in 30 days at a temperature of 5°C as compared with the organisms developing in seven days on ordinary agar at 20°C–22°C. These organisms may be identified by referring to the classification on this page and to Table VIII.

TABLE XVI.

Comparison of Bacteria Developing on Standard and on Special Low Temperature Plates.

Sample		Non-liquefying			Liquefying	
		Acid		Non-acid	Acid	Non-acid
		Lactic	Other			
VIII...	Standard..........	550,000	3,000	1,000	2,000 (2)* (—) (5)	1,000 (2)
	Low temperature....	120,000	....	....	C (—) (2) D (—) (2)	B (—) (2)
IX.....	S.................	2,000,000	....	....	1,000 (2) 1,000 (2)	75,000 (5)
	L.................	320,000	....	F 1,000	....	H (—) (5)
X......	S.................	3,000,000	1,000	....	1,000 (30)	(—) (2) (—) (15)
	L.................	250,000	....	....	C 1,000 (15)	A (—) (15) F 1,000 (10) D 1,000 (15)
XI.....	S.................	20,000,000	....	20,000 20,000	....	30,000 (2)
	L.................	5,000,000	C 3,000	....	B 2,000 (10)	E 10,000 (2)
XIII...	S.................	15,000,000	7,000	1,000	....	5,000 (10)
	L.................	5,000,000				
XIV...	S.................	3,000,000	6,000	12,000 1,000	1,000 (2) 1,000 (2)	
	L.................	1,500,000	....	....	B 1,000 (2) E (—) (2) G. (—) (2)	G (—) (2) F (—) (2)
XV....	S.................	7,500,000	15,000 2,000	1,000	2,000 (5)	
	L.................	3,000,000	....	....	B 1,000 (2)	
XVI...	S.................	3,600,000	6,000	4,000	2,000 (2) (—) (10)	
	L.................	600,000	....	....	B 1,000 (15) D 1,000 (2)	C 1,000 (5)
XVII...	S.................	25,000,000	....	48,000	1,000 (2)	1,000 (2) 1,000 (15)
	L.................	15,000,000	C 1,000	E 10,000		
XVIII..	S.................	14,000,000	....	20,000	20,000 (2)	70,000 (2)
	L.................	2,500,000	....	....	(—) (2)	
XIX.	S.................	4,500,000	8,000 15,000	....	2,000 (30) 1,000 (2)	
	L.................	1,200,000	B 2,000 D 2,000 E 1,000			
XX....	S.................	1,500,000	....	....	10,000 (2)	
	L.................	600,000				
XXI...	S.................	3,000,000	....	1,000 67,000	(—) (10)	6,000 (15) 35,000 (2)
	L.................	560,000				
XXII..	S.................	6,000,000	1,000	....	....	3,000 (5)
	L.................	3,000,000				

*NOTE.—Number of days before liquefaction begins.

CONCLUSIONS.

It was not intended in these investigations to reach final conclusions but only to define the different problems that are furnished by the cold storage of butter, in order to examine some of these later.

From our preliminary results we may outline the cold storage problems as follow:

CREAMERY PROBLEMS.

The creamery problems indicated in the cold storage of butter are the improving of the quality of cream, the advisability of pasteurization, the use of ripened or sweet cream, and the salting and packing. Most of these problems have been taken up by one or more of the experiment stations, but since these results depend so much upon the conditions of churning, and still more upon the care taken in the whole process, the results of one series of experiments do not allow of final conclusions.

From our own work we cannot add very much to the creamery problems, for our samples were made without relation to each other and differ in so many points that no conclusions can be drawn in regard to a single point. We simply make the statement that butter can be kept for 9–12 months in cold storage and still be used as table butter, but that most of our samples lost very much in value. This loss must have been due to dairy or creamery conditions.

SCIENTIFIC PROBLEMS.

The chief problem is to discover what compounds cause an off flavor and how they are produced in butter. When this is known, we can consider how to avoid the off flavor.

The extensively described experiments show that only a few of the cold storage samples have an increased acidity, while most of them did not change in acidity at all, or only very slightly; whereas, all samples kept above the freezing point, and all samples of other authors kept at ordinary temperature showed a very pronounced increase of free acids.

Since in the decomposition of fat, all the different glycerides are usually attacked in the same way, and since less than 10% of the fatty acids of butter have any taste at all, it seems improbable that the rise of acidity of .3°, which is the highest increase noticed in the 12 good samples, could cause a rancid taste.

We found only very few fat-splitting bacteria in fresh butter and none in old butter. The question arises whether there is any other possible way of decomposing fat without the production of free acids, or whether the off flavor is mostly due to cleaveage products of other substances in butter, especially of protein which certainly could give rise to strongly tasting and smelling compounds. It may be recalled that the decrease of liquefying bacteria did not keep step with the decrease of lactic acid bacteria, and that after six months of decrease, we found a distinct increase. If the decomposition of proteids is the cause of the spoiling of cold storage butter the amount of proteids should be decreased as much as possible, and the addition of starter to the churned butter would be the worst thing to improve its quality.

When the products of decomposition in butter are found, the next step is to trace them back to their origin and to determine the factors which caused their production. These will probably be some micro-organisms. To be certain that these organisms are the immediate cause, sterile cream must be churned with pure cultures of them and the resulting butter tested for decomposition. The micro-organisms which cause the off flavor must be found frequently in butter and increase in number at least for a short time. Our investigations show that in our cold storage samples there was but one species of wild yeast very frequent and *Micrococcus lactis varians* often present in butter besides the lactic acid bacteria.

As soon as the problem of the cause of rancidity is solved the question arises of how to keep these organisms from the butter, or, if this should prove to be practically impossible, how to avoid their development in butter. At first, the origin of the specific micro-organisms has to be discovered, whether they come from the cows, the stable, the milker, or the creamery and its utensils. We must then learn how to avoid these dangerous contaminations.

On the other hand, we must try to make the conditions of development in butter as unfavorable as possible. The only two means we have are salt and the effect of temperature. The safest way is certainly the application of high temperature, that is, sterilization; but the consistency of the butter as well as the flavor suffer too much by this treatment. The low temperature entirely checks the growth of many organisms, and other species, develop only very slowly. In the same way salt decreases the rapidity of multiplication very much and may kill many cells by continuous plasmolysis; whereas, others are able to multiply even in concentrated brine. It is, however, questionable whether or not the combined action of both would be advisable, since the salt in a certain way prevents the action of the cold. The water in butter without salt will probably solidify a few degrees below the freezing point, but the addition of salt lowers the freezing point considerably. In some of our butter samples we have saturated salt solution with a freezing point of about —22°C. (—7°F.).

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THE FORMALIN TREATMENT OF WHEAT FOR EITHER LOOSE OR STINKING SMUT.

Press Bulletin No. 19.

Formalin is a 40% solution of formaldehyde. It often falls below this standard on the market, and therefore the purchaser should insist on a guarantee of the strength named.

Preparation of Material. Mix formalin with water in the proportion of one pound or pint of the former to fifty gallons of the latter, stirring well. This solution may be made in a tub, barrel, trough or tank, depending on the amount to be used and the manner of using. The grain may be treated in either of two ways, as follows:

SPRINKLING METHOD.

(1.) Spread a two-inch layer of wheat upon a well swept floor, thoroughly saturated with the solution, then apply the formaldehyde mixture to the grain with a garden sprinkler until thoroughly wet. To this a second layer may be added and similiarly treated, and so on.

(2.) Turn the moistened mass of grain with shovel or scoop till the surface of every kernel glistens with moisture, adding more solution if necessary; then shovel into a compact pile and allow to stand two hours. At the end of two hours spread the grain into as thin a layer as the floor space will permit, and shovel occasionally till dry, when it may be bagged.

Caution.—Thoroughly saturate the floor on which the treating is to be done, with the solution, also all tools used, the bags receiving the treated grain, unless new, and the grain drill as well.

DIPPING METHOD.

(1.) Put the grain to be treated in bags about 1 or 1½ bushels to each. Gunny sacks are much preferred, allowing the solution to pass into the grain and also draining more quickly than cotton bags.

(2.) In this case the solution is prepared in a tub, barrel, trough or tank, according to convenience or necessity. Immerse each bag of grain completely for ten minutes, working thoroughly with the hands or otherwise, till all the grain is wet.

(3.) After ten minutes remove the bag and suspend it over the dipping vat, or place it on draining boards which will return the excess solution for further use.

(4.) After dripping ceases, empty the grain on a clean floor, previously treated. Spread and stir frequently till dry.

(5.) If the grain is to be sown at once it need be dried only sufficiently to allow it to work well through the drill. If seeding is delayed for several days after treatment, by rain or other causes, the grain should be dried well, as remaining in the sacks or pile may injure it.

Caution.—The same precautions should be observed as given for the previous method. Also remember that in this treatment the kernels will swell and therefore due allowance must be made in setting the drill to insure application of sufficient seed.

J. A. JEFFERY,
Professor of Agronomy.

To the Editor:

Dear Sir:—We have received numerous requests for the information contained herein, and an especially urgent one from the Secretary of the Michigan State Miller's Association asking that these facts be disseminated among the wheat growers of the state. Will you please publish? These bulletins are furnished to the press of the state only.

R. S. SHAW,
Director.

FORMALIN TREATMENT OF OATS FOR THE PREVENTION OF SMUT.

Press Bulletin No. 20.

Enormous losses occur annually from the reduction of oat yields by the ravages of smut. This loss can be largely if not entirely avoided by treating the seed with a formalin solution.

Formalin is a 40% solution of formaldehyde; it can be procured from or by local druggists; the standard strength should be guaranteed. The solution most commonly used is made by adding one pound or pint of formalin to from forty to fifty gallons of water.

The treatment may be applied in one of two ways, viz:

(1.) Clean carefully a large area of the granary or barn floor and saturate with solution; upon this spread a layer of grain several or more inches in depth. Apply formaldehyde solution to grain with a garden sprinkler and stir well with shovel. Repeat the sprinkling and stirring until the grain is thoroughly moistened and then shovel into the smallest sized pile possible, where it should remain for not less than two hours. Then spread the grain and dry it sufficiently to pass through the drill if to be sown at once, or dry perfectly if seeding is delayed.

(2.) Put the grain in gunny sacks, about 1½ bushels to each, and immerse from five to ten minutes in a barrel, tank, trough, tub or other receptacle containing the formalin solution. A draining board can be used to return the drip, thus saving both time and material. Dry as heretofore described under 1. Drying may be hastened, in both cases, by spreading the grain on canvass sheets out in the air and sunlight. Bags or sacks other than those used for dipping should be treated, including the grain drill.

In adjusting the seeder, allowance must be made for the swelling of the grain. Formalin should not be added to the water until ready for use. The results secured will depend largely on thoroughness of application.

The same methods will apply in the case of barley.

R. S. SHAW,
Director.

To the Editor:

Dear Sir:—This bulletin is not issued to the Experiment Station mailing list. You can aid the people of your community by publishing the above and urging its use.

R. S. S.

POTATO SCAB—WAYS OF PREVENTION.

Press Bulletin No. 21.

WHAT IT IS.

Potato scab is a fungus growth on the skin of the potato. From this fungus grow spores which live over winter in the soil and on the tubers in storage. Therefore, planting scabby seed generally (but not always) results in a scabby crop. The soil which has produced scabby potatoes is almost sure to produce a scabby crop if planted with potatoes again the following season.

KILLING THE SCAB ON THE SEED.

When potatoes are to be planted on land free from scab the seed tubers should be disinfected to prevent the introduction of the disease by means of scab spores on the seed; but if the land is already thoroughly infected this is of little use. Disinfection may be accomplished in different ways—by soaking the seed in corrosive sublimate solution or in formalin or by exposing it to formaldehyde gas.

CORROSIVE SUBLIMATE TREATMENT.

Make a solution containing one ounce of corrosive sublimate in seven gallons of water. Soak the tubers in this for 1½ hrs. This treatment has been largely superceded by the formalin treatment which is equally effective, more convenient and safer. Corrosive sublimate is very poisonous.

FORMALIN TREATMENT.

Into 30 gallons of water pour one pint of formalin (40 per cent. formaldehyde). Soak the uncut tubers in this solution for two hours. The same solution may be used several times. Take care that the treated tubers are not re-infected by coming in contact with bags or crates which have held scabby potatoes. It is better to make this treatment only a few days before planting. Formalin is not poisonous. Treated seed not needed for planting may be used for food or fed to stock with safety.

FORMALDEHYDE GAS.

When large quantities of potatoes are to be treated formaldehyde gas may be used to advantage as follows: (Recommended by the Maine Station Bul. 149.) "Place seed tubers in bushel crates or shallow slat work bins in a tight room. For each 1000 cubic feet of space spread 23 ounces of potassium permanganate evenly over the bottom of a large, flaring pan or pail placed in the middle of the room. Pour over this three pints of formalin. Close room at once and do not open for 24 to 48 hours."

IMPORTANCE OF SOIL CONDITIONS.

Scabby potatoes are more common on clay and loam than on sandy soil. These soils are more apt to be acid, and on acid soil scab is not common. The scab fungus does not thrive in this kind of soil. Soils which are neutral or slightly alkaline are most favorable to scab. Unfortunately, the soil conditions most favorable to large yields are also most favorable to the growth of the scab fungus.

LIME, ASHES AND STABLE MANURE.

Putting lime, wood ashes or stable manure upon the potato field tends very much to increase the trouble with scab. These substances lessen the acidity of the soil and thereby make it more favorable for the growth of the fungus which may be in the soil. They do not cause the scab as some believe, simply make favorable conditions for its growth.

USE OF GREEN CROPS AND FERTILIZER.

By plowing under some green crop like clover or rye a soil that has become alkaline may be brought back to an acid condition. This is some help but cannot be relied upon to entirely prevent scab. An application of sulphate of ammonia will reduce the loss from scab as well as supply plant food.

ROTATION OF CROPS.

A rotation of crops will assist, considerably, in the control of scab. On soil badly infested with scab it is usually cheaper to abandon potato culture for a time than to try and combat the disease. Scab may persist in the soil several years—just how long is unknown. Much depends on the treatment of the soil and kind of crops grown. Probably, the time is shorter in tilled land than in sod. Beets harbor scab; so do turnips, probably.

H. J. EUSTACE, Horticulturist.

MICHIGAN

STATE AGRICULTURAL SOCIETY.

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY FOR THE YEAR ENDING JUNE 30, 1909.

OFFICERS 1908-9.

President—Fred Postal, Detroit.
Vice-President—L. Whitney Watkins, Manchester.
Secretary—I. H. Butterfield, Detroit.
Treasurer—John McKay, Romeo.
Business Manager—James Slocum, Detroit.

EXECUTIVE COMMITTEE.

(Terms Expire January, 1909.)

T. F. Marston	Bay City, Bay County.
Archibald J. Peek	Jackson, Jackson County.
A. E. Stevenson	Port Huron, St. Clair County.
C. A. Tyler	Nottawa, St. Joseph County.
Nicholas J. Whelan	Holland, Ottawa County.
Wm. Dawson	Sandusky, Sanilac County.
Vincent V. Green	Detroit, Wayne County.
Lawrence W. Snell	Highland Park, Wayne County.
Geo. Kelly	North Branch, Lapeer County.
Daniel Thomas	Pontiac, Oakland County.

(Term Ending January, 1910.)

A. J. Doherty	Clare, Clare County.
W. J. Galbraith	Calumet, Houghton County.
Wm. J. Terney	Roscommon, Roscommon County.
L. C. Holden	Sault Ste. Marie, Chippewa County.
F. F. Ransford	Caro, Tuscola County.
W. W. Collier	Pontiac, Oakland County.
L. R. Taft	East Lansing, Ingham County.
Geo. B. Horton	Fruit Ridge, Lenawee County.
D. D. Aitken	Flint, Genesee County.
Chas. Edwards	Carleton, Monroe County.

EX-PRESIDENTS.

(Members Ex-Officio.)

T. W. Palmer	Detroit, Wayne County.
John T. Rich	Lapeer County, P. O., Detroit.
I. H. Butterfield	Detroit, Wayne County.
E. Howland	Pontiac, Oakland County.
Eugene Fifield	Bay City, Bay County.

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

Business—A. J. Doherty, Lawrence W. Snell, I. H. Butterfield.
Finance—D. D. Aitken, Eugene Fifield, T. F. Marston.
By-Laws and General Rules—W. J. Galbraith, Chas. Edwards, V. V. Green.
Premium List—Eugene Fifield, I. H. Butterfield, W. W. Collier, A. J. Peek, D. D. Aitken, L. R. Taft and the President.
Reception—John T. Rich, A. E. Stevenson, Geo. B. Horton.
Program—C. A. Tyler, L. W. Watkins, Chas. Edwards, the President and Marshal.

SUPERINTENDENTS.

Cattle—C. A. Tyler.
Horses (except for speed)—L. W. Watkins.
Horses (Speed)—Eugene Fifield.
Sheep—W. E. Boyden.
Swine—George Kelly.
Poultry—Daniel Thomas.
Farm and Garden Products—W. J. Terney.
Dairy—Lawrence W. Snell.
Apiary—F. B. Ransford.
Farm Implements and Machinery—Vincent V. Green.
Vehicles—A. E. Stevenson.
Main Building—N. J. Whelan.
Art—A. H. Griffith.
Needlework—Mrs. Belle F. Clark.
Horticulture—Prof. L. R. Taft.
Educational—L. C. Holden, Assistant Supt., Thos. M. Sattler.
Mining Exhibit—W. J. Galbraith.
Gates—Finance Committee.
Marshal and Superintendent of Police—A. J. Peek.
Concessions—The Business Committee.
Transportation—Chas. Edwards.
Forage—Wm. Dawson.

THE FAIR OF 1908.

Was held September 3rd to 10th inclusive. The weather was excellent and the attendance well up to that of 1907.

The entries and exhibits were somewhat smaller in live stock and greater in other departments. The total receipts were greater than for any fair yet held. In general, there is manifestly and increasing interest in the state fair. Continued improvement has been made in the grounds the most important being the construction of 60,000 square feet of concrete walk and of two large barns for speed horses.

PROCEEDINGS OF THE BUSINESS AND EXECUTIVE COMMITTEES.

MEETING OF THE SOCIETY.

The annual meeting of the society was held at the band stand on the fair grounds Wednesday, September 8, 1908. The Vice-president, L. W. Watkins, presided. In the absence of the secretary, A. E. Stevenson acted as secretary.

The nomination of candidates for officers for the ensuing year being in order, on motion, the following persons were selected as candidates, to be voted for at the annual election, to be held on Thursday, September 10, 1908.

For President—Fred Postal of Detroit.

For Vice-President—L. Whitney Watkins of Manchester.

For Secretary—I. H. Butterfield of Detroit.

For Treasurer—John McKay of Romeo.

For members of the Executive Committee for two years— T. F. Marston, Bay county; Archibald J. Peek, Jackson county; A. E. Stevenson, St. Clair county; C. A. Tyler, St. Joseph county; Nicholas J. Whelan, Ottawa county; William Dawson, Sanilac county; Vincent V. Green, Wayne county; Lawrence W. Snell, Wayne county; Geo. Kelly, Lapeer county; Daniel Thomas, Oakland county.

On motion adjourned.

ELECTION.

The annual election of officers of the society was held at the press booth in the Administration Building on Thursday, September 10, 1908, in charge of the judges appointed by the Executive Committee, viz., F. J. Lessiter of Oakland county, W. E. Boyden of Bay county, S. D. Lapham of Wayne county. The polls were open from nine o'clock A. M. to five o'clock P. M.

At the closing of the polls, the votes were counted with the following result, as reported by the judges:

Election 1908—

Whole number of votes cast	129
For President, Fred Postal received	126
For Vice-President, L. Whitney Watkins received	127
For Secretary, I. H. Butterfield received	129
For Treasurer, John McKay received	129

For member of the Executive Committee:

T. F. Marston received	129
Archibald J. Peek received	129
A. E. Stevenson received	129
C. A. Tyler received	129
Nicholas J. Whelan received	129
George Kelly received	129
Wm. Dawson received	129
Vincent V. Green received	129
Lawrence W. Snell received	129
Daniel Thomas received	129

Each of these persons having received a majority of the whole number of votes cast, was declared duly elected to the respective offices named.

Signed by F. JAY LESSITER,
WM. E. BOYDEN,
SAMUEL D. LAPHAM,
Judges of Election.

The officers elected as above having been notified of their election, each accepted the office to which he was elected except Daniel Thomas, who declined to serve.

At the annual meeting of the Executive Committee, January 12, 1909, Mr. F. J. Lessiter of Clarkston, Oakland county, was elected to fill the vacancy caused by the declination of Mr. Thomas.

I. H. BUTTERFIELD, Secretary.

FINANCE COMMITTEE.

The Finance Committee, Messrs. Aitken, Fifield and Marston, met at the offices of the society on January 9, 1909. Mr. John McKay, Treasurer, was also present.

A partial examination of bills and accounts was made, but vouchers and checks were not compared and no report was made.

I. H. BUTTERFIELD, Secretary.

The President directed that the annual winter meeting of the Executive Committee be held at the Downey House, Lansing, at the time named in the Constitution—Monday, January 11, 1909.

ANNUAL WINTER MEETING OF THE EXECUTIVE COMMITTEE.

The Executive Committee met pursuant to notice and call of the President, at the Downey House, Lansing, Monday evening, January 11, 1909, at 8 o'clock P. M.

Called to order by the President. Minutes of the last meeting read and approved. Roll called. There were present—The President, Vice-President, Secretary, Treasurer, and Messrs. Marston, Peek, Stevenson, Tyler, Dawson, Green, Snell, Doherty, Galbraith, Terney, Holden, Taft, Aitken, Fifield. Quorum present.

REPORT OF THE SECRETARY.

FINANCIAL.

The Secretary collected for:

Stall, pen and poultry fees	$1,498 35
Memberships	818 00
Race Entries	650 00
Total	$2,966 35

All of which has been deposited with the Treasurer.

The following shows the entries in the several classes and divisions, with the amounts offered and awarded in each class:

Class.		Sgl. Entries.	Hds. and Swpstks.	Offered	Awarded.
1.	Short Horn Cattle	81	29	$1,212 00	$1,069 00
2.	Polled Durham Cattle	16	6	651 00	280 00
3.	Hereford Cattle	110	14	651 00	522 00
4.	Aberdeen Angus (Special)	9	..	651 00	174 00
	Aberdeen Angus	10	5		
5.	Galloway	26	9	651 00	420 00
6.	Jersey	71	22	651 00	529 00
7.	Guernsey	29	10	651 00	373 00
8.	Holstein-Friesian	69	21	726 00	681 00
9.	Ayrshire	20	5	651 00	270 00
10.	Red Polled	32	11	651 00	382 00
11.	Brown Swiss	24	16	651 00	353 00
12.	Dairy Test	11	..	100 00	100 00
13.	Fat & Feeders' Steers	31	..	192 00	123 00
		464	138	$8,089 00	$5,339 00

24 Champion Medals	44
Gr. Champion Cups	23

JUDGING CONTEST.

Twenty-four young men competed in the Live Stock Judging Contest. The prizes were awarded as follows:

On Cattle: Chas. F. Dawson, Central Lake, 2 yr. Short Horn Heifers......Medal.
On Horses: C. J. Ovaitt, Sta. A., Bay City; Irwin Elmer Devereau, were tied ....Medal.
On Sheep: Jas. R. Rice, Pontiac, 89 points, 1 yr. Shrop. Ewes ....Medal.
On Swine: A. R. Vincent, Croswell, 82 points, 1 yr. Berk. Sows ....Medal.
Championship: All Classes, Jas. R. Rice, 294 points out of 400 ....Cup.

HORSES.

14.	Standard Bred	55	$489 00	$383 00
15.	Non-standard Geldings and Mares	48	225 00	225 00
16.	Roadsters	43	246 00	231 00
17.	Saddle Horses	51	240 00	259 00
18.	Carriage and Coach	70	432 00	373 00
19.	American Carriage	51	538 00	391 00
20.	Hackney	19	538 00	232 00
21.	French Coach	1	538 00	20 00
22.	German Coach	..	538 00	......
23.	Percheron	25	538 00	266 00
23-a.	Special Percheron	20	538 00	......
24.	Clydesdale	14	538 00	177 00
25.	Shire	1	538 00	20 00
26.	Belgian	6	538 00	106 00
27.	Grade Draft	60	523 00	395 00
28.	Shetland	17	172 00	96 00
29.	Jacks and Mules	12	130 00	101 00
	Total	493	$6,761 00	$3,275 00

Champion Cups 14

SHEEP.

30.	Amer. Merinos	48	8	$242 00	$224 00
31.	Delaine Merinos	41	6	242 00	216 00
32.	Franco-American	65	11	242 00	323 00
33.	Rambouillet	108	16	242 00	242 00
34.	Lincoln	40	6	242 00	204 00
35.	Leicester	37	6	242 00	226 00
36.	Cotswold	55	10	242 00	218 00
37.	Shropshire	93	14	242 00	242 00
37-a.	Shrop. Assoc. Specials	6	..	25 00	25 00
37-b.	Shrop. Edwin George Specials	14	..	55 00	55 00
38.	Oxford Down	31	4	242 00	186 00
38-a.	Oxford Down Specials	4	2	45 00	45 00
39.	Hampshire	44	8	242 00	230 00
40.	Southdown	50	8	242 00	226 00
41.	Horned Dorset	60	11	242 00	228 00
42.	Fat Sheep	30	..	72 00	68 00
43.	Angora Goats	6	2	164 00	74 00
43-a.	Angora Goats Specials	..	1	(Cup) * * *	296 00
		726	119	$3,140 00	$3,112 00

Champion Medals 48
Gd. Champion Cups 26

* * * Specials allowed in Rambouillet and Horned Dorset.

SWINE.

44.	Berkshire	82	23	$412 00	$392 00
45.	Poland China	74	19	412 00	370 00
46.	Essex	34	11	412 00	306 00
47.	Small Yorkshire	11	4	412 00	108 00
48.	Victoria	24	7	412 00	160 00
49.	Chester White	74	18	412 00	332 00
50.	Large Yorkshire	5	2	412 00	46 00
51.	Duroc Jersey	78	18	412 00	404 00
52.	Tamworth	36	10	412 00	257 00
53.	Hampshire	73	13	412 00	263 00
54.	Fat Hogs	..	..	44 00	......
	Total	491	125	$4,164 00	$2,638 00

Champion Medals 40
Gd. Champion Cups 20

POULTRY.

55. American Class:

Barred Rock	27	
White Rock	33	
Buff Rock	35	
Partridge Rock	2	
Silver Penciled Rock	2	
Golden Wyandottes	16	
Silver Wyandottes	11	
Buff Wyandottes	20	
Black Wyandottes	10	
Mottled Java	4	
White Wyandottes	35	
Silver Penciled Wyandottes	8	
Partridge Wyandottes	18	
Columbian Wyandottes	18	
R. C. Rhode Island Reds	23	
S. C. Rhode Island Reds	40	
Buckeyes	9	
Dominiques	8	
White Java	3	
Total	322	
Amount awarded		$286 50

ASIATIC CLASS.

Lt. Brahma	18	
Dark Brahma	9	
Buff Cochin	16	
Partridge Cochin	12	
Black Cochin	8	
White Cochin	13	
Black Langshan	23	
White Langshan	12	
Total	111	
Amount awarded		142 50

ENGLISH CLASS.

Colored Dorking	2	
Silver Grey Dorking	6	
White Dorking	2	
Buff Orpington	20	
White Orpington	15	
Black Orpington	14	
Red Caps	7	
Lakenvelders	0	
Total	66	
Amount awarded		81 50

FRENCH CLASS.

Houdans	14	
Favorelles	0	
Total	14	
Amount awarded		17 00

GAME CLASS.

B. Br. Red	11	
Br. Red	2	
Silver Duckwing	7	
Golden Duckwing	4	
Red Pyle	8	
White Game	4	
Black	3	
Birchen	0	
Cornish Indian	28	
White Indian	11	
Black Br. Red M. G.	1	
Total	79	
Amount awarded		$84 00

MEDITERRANEAN CLASS.

Black Spanish	13	
Black R. C. Minorcas	14	
Black S. C. Minorcas	23	
White R. C. Minorcas	10	
White S. C. Minorcas	11	
Andalusians	13	
R. C. White Leghorns	29	
S. C. White Leghorns	41	
R. C. Black Leghorns	10	
S. C. Black Leghorns	11	
R. C. Brown Leghorns	27	
S. C. Brown Leghorns	9	
R. C. Buff Leghorns	6	
S. C. Buff Leghorns	28	
Silver Duckwing Leghorns	13	
Total	258	
Amount awarded		280 00

HAMBURG CLASS.

Gold Spangled	6	
Silver Spangled	26	
Gold Penciled	10	
Silver Penciled	11	
Black	9	
White	8	
Total	70	
Amount awarded		85 00

POLISH CLASS.

White Crested Black	11	
White	7	
Golden	10	
Silver	12	
Buff Laced	8	
Golden Bearded	3	
White Bearded	0	
Silver Bearded	8	
Total	59	
Amount awarded		69 50

GAME BANTAMS.

Black Br. Red	10	
Br. Red	11	
Silver Duckwing	5	
Golden Duckwing	8	
Red Pyle	10	
White	2	
Black	0	
Birchen	5	
Cornish Indian	0	
White Indian	0	
Blk. Br. Red M. G.	0	
Total	51	
Amount awarded		$73 50

ORNAMENTAL BANTAMS.

Golden Seabright	20	
Silver Seabright	10	
R. C. White	13	
R. C. Black	14	
White Booted	0	
White Cochin	23	
White Jap	7	
Black Jap	0	
White Crested Polish	8	
Buff	23	
Partridge	16	
Black	13	
Lt. Brahma	8	
Dark Brahma	7	
Black Tail Jap	14	
Barred Rocks	16	
R. C. Buff	0	
White Leghorn	0	
Total	192	
Amount awarded		213 00

MISCELLANEOUS CLASS.

Sumatra Black	6	
Mottled Anconas	15	
Silkies	4	
Total	25	
Amount awarded		27 00

TURKEY CLASS.

Bronze	6	
White	10	
Buff	8	
Black	5	
Slate	8	
Narragansett	8	
Total	39	
Amount awarded		46 50

DUCK CLASS.

Pekin	21	
Rouen	14	
Aylsbury	17	
Indian Runner	18	
White Call	14	
Grey Call	14	
Black India	14	
Cayuga	14	
Crested White	12	
Muscovy Colored	14	
Muscovy White	8	
Total	160	
Amount awarded		$189 00

GOOSE CLASS.

Toulouse	17	
Embden	10	
African	10	
White China	6	
Black China	8	
Buff	2	
Total	53	
Amount awarded		42 00

ORNAMENTAL CLASS.

Pea Fowls	17	
Pigeons	25	
Bengian Hares	47	
Total	139	
Amount awarded		55 00
Non-enumerated	44	
Grand total	1682	
Grand total amount awarded		$1,717 25

AGRICULTURE—FARM AND GARDEN PRODUCTS.

Class.			Offered.	Awarded.
56.	Grains and Seeds	188	$438 00	$297 50
	Corn	173	249 00	252 50
	Non-enum. Gr. Seeds and Corn	9	......	......
57.	Roots and Vegetables	541	330 25	263 50
	Collections	52	207 00	290 00
58.	County Exhibits	9	600 00	440 00
		972	$1,824 25	$1,543 50

DAIRY.

59.	Cheese	43	$174 00	$175 06
	Creamery Butter	69	100 00	99 81
	Dairy Butter	15	50 00	50 07
60.	Domestic Mfgrs.	54	63 50	60 35
		181	$487 50	$385 29

APIARY.

61.	Bees and Honey	51	$207 00	$188 00

ART.

			Offered.	Awarded.
62.	Professional	67	$382 50	$177 00
63.	Amateur	434	256 50	272 50
		501	$643 00	$449 50

NEEDLEWORK.

64.	Amateur	807	$365 50	$272 25
65.	Professional	264	270 00	169 00
66.	Non-enumerated	90	......	69 00
		1161	$735 50	$510 25

HORTICULTURE.

67.	County Exhibits	23	$800 00	$695 00
68.	Collection & Displays	72	1,010 00	777 00
69.	Single Plates:			
	Apples	585	198 00	156 00
	Pears	257	87 75	64 25
	Peaches	185	114 75	89 75
	Plums	182	101 25	92 25
	Grapes	49	63 00	33 25
	Quinces	12	15 75	7 25
70.	Dried and Canned Fruits	323	230 00	217 00
71.	Plants in Pots	14	272 00	60 00
72.	Plants in Beds and Boxes	23	321 00	148 00
73.	Cut Flowers Professional	25	277 00	114 00
74.	Plants Amateur	0	277 00	......
75.	Cut Flowers Amateur	79	29 75	89 00
	Non-enumerated	19	132 00	2 00
		1847	$3,652 75	$2,544 75

EDUCATIONAL.

76.	High School	99	$223 00	$147 00
77.	Grammar	365	275 00	256 00
79.	Intermediate	332	207 00	200 00
80.	Primary	195	102 00	100 00
	Kindergarten	29	33 00	33 00
	Manual Training	78	192 00	110 00
	Village	39	82 00	56 00
	District	..	......	......
	Non-enumerated	6	105 00	12 00
		1143	$1,219 00	$914 00

	Single Entries.	Hds. and Specials.	Money Offered.	Amount Awarded.
Grand Total	9531	372	$32,152 75	$22,233 25

Medals Awarded	137
Cups Awarded	84

REPORT OF THE TREASURER.

Detroit, January 2, 1909.

Mr. President and members of the Executive Committee of the Michigan State Agricultural Society.

Gentlemen—I beg to submit my annual report for the year ending December 31, 1908.

Balance, Peoples' State Bank, Dec. 31, 1907	$4,766 04	
Balance, Dime Savings Bank, Dec. 31, 1907	20 38	
Cash Item, John McKay	114 50	
Cash Item, C. A. Floyd	145 68	
Pay Roll uncalled for	84 67	
Pay Roll, excess	11 76	
Outstanding checks, last report	506 84	
Deposits, Peoples' State Bank, Dec. 31, 1907 to Dec. 31, 1908	214,198 74	
		$219,848 61

Disbursements.

Total checks paid as per bank book	$216,856 47	
Outstanding checks paid or re-issued	506 84	
No. 324 check, Nov. 6, 1905, paid by Dime Bank	4 50	
Balance Dime Bank account deposit in Peoples' Bank.	15 88	
Cash Item, John McKay, allowed	114 50	
Cash Item, C. A. Floyd, allowed	145 68	
Pay Roll, deposited May 27, 1908	84 65	
Pay Roll, excess deposited May 27, 1908	11 84	
Balance on deposit, Dec. 31, 1903	2,108 31	
		$219,848 61
Balance on hand this date		$2,108 31

Receipts.

Concessions:		
Dining Halls and Lunch Stands	$6,882 00	
Percentages on Midway shows	6,383 31	
Ice Cream Cones	1,217 28	
Miscellaneous Concessions	17,229 82	
Exhibitors' Space, Main Bldg.	2,238 52	
		$33,950 93
Gate Admissions:		
Advance Sale Tickets in Detroit	$10,452 20	
Advance Sale Tickets in State	4,455 32	
Half-fair Tickets	274 75	
Gate Sales	48,009 50	
White Star Coupon Sales	203 35	
		$63,395 12
Grand Stand:		
Afternoon	$10,863 00	
Evening	7,086 50	
Reserved Seats (Advance)	120 00	
		$18,069 50
Ground Rentals:		
Detroit Driving Club Advance	$10,000 00	
Rent on five year contract	128 05	
		$10,128 05

General and Miscellaneous Receipts:		
Memberships	$818 00	
Stall Rentals less rebate	1,485 35	
Stall Rentals speed barns	102 00	
Entry Fees, Races	4,139 50	
Percent from Winners	2,060 00	
Check Room Receipts	280 20	
Electric Light to Concessions	247 25	
Premium List Advertising	580 00	
Catalogue Advertising	3,603 25	
Score Card Races	504 00	
Detroit Driving Club	19 75	
Miscellaneous	131 52	
From State Appropriation	10,000 00	
		$23,970 82
Special Premiums Donated:		
American Short Horn Br. Association	$437 40	
American Hereford Cattle Br. Association	123 00	
Holstein-Friesian Cattle Association	75 00	
		635 40
Total Receipts		$150,149 82
This total includes $10,000 rec'd from the Detroit Driving Club for five years lease of the track and stables. Therefore the amount of $800.00 for the four years lease still measured should be deducted		$800 00
		$142,149 82

Expenditures for the year 1908.

Summary:	
Advertising	$8,601 24
Attractions	17,501 46
Business Committee	802 39
Maintenance of Buildings	3,703 22
Departments:	
Apiary	81 12
Educational	244 56
Agricultural	217 08
Vehicle	70 36
Needlework	202 02
Cattle	178 02
Dairy	294 25
Art	139 76
Horticulture	311 14
Implements and Machinery	114 53
Horse	422 74
Transportation	60 00
Swine	153 00
Poultry	320 35
Speed	12,008 26
Sheep	166 92
Police	1,044 49
Express and Freight	81 29
Electric Light	418 10
Forage	66 57
Care of Grounds	3,697 88
Gates and Grand Stand Ticket Takers	997 07
Interest Paid	8,299 88
Ice Cream Ticket Takers	302 95
Sunday Expense Ex. Com.	91 05
Badges, Diplomas, etc.	240 69
Miscellaneous Expenses	3,625 37
President, Expense and Salary	309 50

Printing and Stationery	$1,545 75	
Postage	650 00	
Offices and Salaries	5,029 61	
Ticket Sellers	320 35	
Treas. Office, Salary and Expenses	905 56	
Ticket Takers for Shows	1,271 55	
Catalogue Expense, Printing	2,669 89	
Check Room Expense	91 40	
Sundry Bills of 1907 Paid	2,836 70	
Finance Committee	355 45	
Premiums Paid	21,718 19	
Premiums awarded and not paid	879 00	
		$102,241 96

Permanent Improvements.

Tools, Furniture and Fixtures	$1,300 77	
Improvement of Grounds (Walks, Drives, Sant. Tank)	2,779 57	
Payment on Land. Dwyer Cou't.	500 00	
Improvement of Buildings	387 76	
Material and Labor, Electric Light	300 00	
Concrete Walks and Area	4,847 64	
Improvement to Track	7,084 79	
Two Speed Barns, Judges' Stand, etc.	7,813 83	
		$14,898 62

REDUCTION OF INDEBTEDNESS.

Notes Paid	$28,799 70
1907 Accounts Paid	3,014 95
Present Indebtedness:	
Bonds	100,000 00
Notes	62,300 16
	$194,114 81

PERMANENT IMPROVEMENTS ADDED IN 1908.

Furniture, Tools, Implements and Fire Extinguishers	$351 00	
One Hand Spray Pump	15 00	
Office Furniture	106 65	
Show Cases	158 00	
One Chemical Fire Engine	500 00	
One Hand Lawn Mower	9 21	
One Horse Lawn Mower	90 00	
Glass for Horticulture Department	99 68	
		$1,329 54
Land from Jas. Dwyer		500 00
Improvements to Grounds:		
Septic Tank	$1,233 12	
Improvements to Walks and Roads	973 05	
Iron Fence	573 40	
		$2,779 57
Improvement of buildings		387 76
Cement Walks		4,847 64
Improvement to Tracks		7,084 79
Speed Barns, Judges' Stands, etc.		7,813 83
Added to Electric Light Fixtures		2,500 00
		$25,413 59

REDUCTION OF INDEBTEDNESS.

Notes out January 1, 1908	$81,099 86
Notes out January 1, 1909	64,809 36
Reduction	$16,290 50
1907 accounts paid	3,014 95
Total reduction	$19,305 45

PRESIDENT'S ADDRESS.

Directors and Officers of the Michigan State Agricultural Society:

Gentlemen—This is the fourth consecutive annual meeting that I have had the honor of presiding over as President of your society, and it affords me much pleasure to again address you.

During this period a large amount of business has been transacted and we have dealt individually and collectively with a great many people and corporations, and believe that the annual fairs and all business transactions are satisfactory to a very large majority of the people of Michigan, more especially those who are familiar with its workings. I am proud of the record the society has made during that time. We have been criticized by some of the agriculturalists, but we are liberal enough in our views to believe that if the people who have criticized our methods were in close touch with the affairs of the Michigan Agricultural Society and knew how earnestly and honestly we are striving for its success and how hard we have all worked to make it what it is today, they certainly would not censure us. We all realize that the State Fair, is an agricultural society, and it must be conducted along those lines, and it is our earnest desire that the farmers of the state cooperate with us in making the Michigan State Fair one of the very best and most successful in the United States.

The spirit of the age is progressive, and whether it be a merchant, manufacturer, farmer, doctor, lawyer or teacher, the age demands forward movement in the methods and systems of conducting each line of business. The successful man today is the one who keeps in touch with all modern methods in his individual lines, who adopts new methods, new machinery new ideas which may be applicable to his particular line when he finds that his business demands it. Every corporation, every society and every organization must adopt this spirit in order to become successful in every respect.

When the present management took charge of the Michigan State Agricultural Society, its indebtedness was about $225,000, of which $100,000 was original, bonded indebtedness, and $125,000 floating indebtedness. During the period of time that has elapsed since the present executive board has been in control of its affairs, we have reduced the indebtedness in the neighborhood of $50,000, and made improvements to the amount of over $170,000. In our eagerness to improve the grounds, erect new buildings and pay the debts, possibly concessions have been sold which would be eliminated if the society was out of debt or owned by the state. However, I do not feel that the means which have been employed to improve the grounds and pay off indebtedness, have been such that they have reverted against the people of the State of Michigan or ourselves; however, I am aware that we all do not look at it from the same standpoint.

There has been some agitation in favor of a one-week fair instead of an eight-day, to open Monday morning and close Saturday night. I do not favor making any change at this time for various reasons. I do not believe that it is possible to organize a force of workmen who, without some experience, would be able to handle a crowd of 75,000 people who usually throng our grounds on Labor Day, which, if a one-week fair was held, would be the opening day.

We must not lose sight of the fact that the Michigan State Fair is carrying quite a large indebtedness at the present time, and a large number of the notes that are outstanding are indorsed personally by some of the officers, and I, as one of the indorsers, feel that the uncertainty of the weather for a short week is too great a risk. By opening on Thursday and closing on Friday night, the fair extends over a period of nine days, being closed on Sunday, and it is seldom at that time of the year that we find nine days of bad weather. We are sure to have good weather at least part of the time, and in such case will not meet with losses, and we are quite sure to make enough money to very materially reduce our indebtedness. It will be remembered that Grand Rapids holds a one-week fair, and only a short time ago the whole week had only one-half day of pleasant weather. Detroit does not want to encounter any such discouraging propositions as that of Grand Rapids.

It will be noticed that, although we gave very much larger purses for our races this year, yet finally they did not earn us any more money than when the purses were small, and unless it is deemed advisable by this board to engage the services of some one to personally look after this and secure the entries to our races, I would recommend smaller purses and a less number of days for racing which would tend to encourage the entry of more horses owned in the state and very materially decrease expenses.

Minnesota has set aside one day for automobile races. Last year they gave the local automobile club a certain amount of money to take entire charge of the races, paying the prizes, and it was very successful. The attendance was exceptionally large and the plan proved very successful from a financial standpoint.

Complaint emanated from two departments at the last fair—the forage and cartage. I now recommend that the forage department be handled by the society, buying hay, straw and feed at wholesale, shipping direct to the fair-grounds and placed in charge of a person whose only duty will be to weigh and deliver to exhibitors at the absolute cost to the society.

I would also recommend that some arrangements be made for cartage which will result in handling the exhibits at the lowest possible price. I also recommend that a resolution be passed which will prevent those connected with the Michigan State Fair from buying, in any way, interests in any concession or amusement which is operated for profit.

We were able to reduce the pass list last year under 1907, 6,508 admissions. I believe that this can be further reduced by very careful watching to see that those who are not entitled to them are not given passes.

I want to call your attention to the statement of receipts from the grand stand for 1908. It will show that 12,069 availed themselves of the opportunity to go inside of the enclosure and on the bleachers, paying 25c for this privilege, during the six afternoons, and that 15,818 people paid 50c for a seat in the grand stand, and only 120 paid 75c, and 1,104 paid $1 each. It is very important that 25c seems to be the popular price for the grand stand, and I would suggest selling all grand stand admissions for 25c and the box seats for 50c, reserving only box seats. I think the grand stand will bring just as much money and the people who attend the fair will be better satisfied. I believe that it is unjust to the farmers of Michigan to charge more than 25c general admission to the grand stand. Many of these people come from long distances and are compelled to pay railroad fare, and to meet many other expenses which the city people do not have to meet in order to visit the fair, and I believe that it is only just to the farmers of Michigan that we make a general admission of 25c to the grand stand.

FRED POSTAL, President.

The Secretary announced that Mr. Daniel Thomas declined re-election as member of the Executive Committee.

On motion the President was requested to appoint a committee of three to present the name of a suitable person to fill the vacancy caused by the declination of Mr. Thomas, the committee to report at the session of Tuesday, January 12. The President appointed Mr. Tyler, Mr. Aitken, Mr. Marston.

The Secretary presented the matter of protest made at the fair of 1907 by J. L. Walton and Wm. Grimes against awards to Leicester sheep exhibited by Wm. Newton, of Pontiac, with report of Mr. A. E. Stevenson thereon.

Mr. Stevenson recommended that the protest be sustained as to the ram and ewe 2 years old, and that the amount awarded to these be deducted from Mr. Newton's awards for that year.

It was moved that this report be adopted and that the amount of $180.00 be paid Mr. Newton, to be accepted in full for balance due him on premium awards of 1907. Carried.

The protest of exhibitors of Rambouillet and Horned Dorset sheep against awards to sheep not in their place at the time stated in the rule (Friday, September 4, at 9 o'clock a. m.) was taken up. It was moved that the protest be sustained and that the reserve awards be advanced to occupy the position they would have occupied if the protested sheep had not been exhibited, and that the cash awards be paid the protested sheep that they received when exhibited. Motion carried.

Mr. Aitken moved that the medal and cup awards in the above named classes be withheld. Carried.

Mr. Watkins presented an invitation from the State Board of Agriculture to attend a meeting and banquet to be given to the members of the Live Stock Breeders at the Agricultural College on the evening of January 12. The invitation was accepted with thanks.

On motion the Secretary was instructed to invite the several stock breeders' associations now in session to send delegates to meet with the Premium List Committee of this society for conference on live stock exhibition at the State Fair.

The President appointed the Committee on Premium List as follows: Messrs. Fifield, Tyler, Aitken, Stevenson, Taft, Terney and Butterfield.

Committee on Rules and By-laws: Messrs. Galbraith, Green and Whelan.

On motion adjourned to Tuesday Morning at 9 o'clock.

TUESDAY, JANUARY 12.

The Executive Committee met at the Downey House at 9 o'clock a. m. as per adjournment. Called to order by the President. Roll call.

The following members present: The President, Vice-President, Secretary, Treasurer, and Messrs. Marston, Peek, Stevenson, Tyler, Whelan, Dawson, Green, Snell, Kelly, Doherty, Galbraith, Terney, Holden, Taft, Aitken and Fifield—19. Quorum present.

The President delivered his address and the reports of superintendents were reserved and referred to the proper committees.

On motion of Mr. Tyler—a committee of three—Messrs. Tyler, Stevenson and Aitken—was appointed to consider the address of the President and report on the recommendations therein.

Mr. Galbraith called attention to the fact that this business practice did not conform to some of the rules and suggested that the committee on rules be authorized to report such changes as would remedy this difference.

The President suggested that the committee on rules act on this matter.

On motion of Mr. Doherty a committee of three—Mr. Galbraith, Mr. Fifield and Mr. Aitkin—was appointed to prepare a revision of the constitution, to be submitted to the society at its annual meeting in September, for approval or rejection. Carried.

Mr. Aitken moved that this committee act also as a legislative committee in case it is thought best to ask amendment or change in the act incorporating the society, and to prepare any necessary rules for the government of the society under its present or amended articles. Carried.

The committee appointed to consider the President's address reported as follows: "Your committee to consider the address of the President and report thereon recommends that the suggestions relative to the Forage Department being handled by the society and forage furnished to exhibitors at cost, be adopted.

"Also that the recommendation that arrangements for cartage on the fair-grounds at the lowest possible cost be made, be adopted.

"Also that the recommendation that a rule be adopted prohibiting any one officially connected with the fair from buying or being interested in any concession or amusement which is operated for profit, be adopted.

"Also that the suggestion regarding the time of holding the fair be referred to the committee of the whole."

On motion the report of the committee was accepted and adopted.

On motion of Mr. Fifield the dates of the next fair were fixed for September 2, 3, 4, 6, 7, 8, 9 and 10, 1909.

Mr. Stevenson moved that exhibits of live stock be required to be on the grounds and ready for exhibition not later than Monday, September 6, at 9 o'clock a. m., and remain until Friday, September 10, at 4 o'clock p. m., and that all other exhibits except cut flowers shall be on the grounds in readiness for exhibition at 9 o'clock a. m. Friday, September 3, whether exhibiting for premiums or otherwise, and shall remain until Friday, September 10, at 4 o'clock p. m. (Except that the general superintendent may in his discretion allow heavy machinery having its own motive power to be placed on cars after 1 o'clock p. m. of that day.) Carried.

Mr. McKay moved that the names of judges of the several classes of live stock be printed in the premium list. Carried.

The protest of E. M. Moore against the awards in Delaine Merinos to A. A. Wood & Sons on the ground that the sheep shown had French blood and therefore were not eligible in the Delaine class, was considered.

The testimony showed that the sheep were recorded in the Standard Delaine Register, which registerd sheep with French or Rambouillet blood.

On motion of Mr. Tyler the protest was not sustained.

The committee appointed to recommend a suitable person to fill the vacancy on the Executive Committee in place of Daniel Thomas, who declined re-election, reported the name of F. Jay Lessiter, of Oakland county.

On motion Mr. Lessiter was declared elected a member of the Executive Committee.

The question of providing a building for the vehicle and implement departments was discussed. A plan was suggested to ask exhibitors in these departments to advance rent for space for a term of years, and with this money so advanced to erect a building. This seemed to meet with favor, but no action was taken.

Mr. Aitken moved that the Premium List Committee prepare a revision of the premium list, and that it then be referred to the Business Committee, and when approved by the Business Committee it be the premium list for the fair of 1909. Motion carried.

Mr. Galbraith, of the Committee on Rules, said this committee was not ready to report, and moved that the committee be directed to prepare its report, and present to the Business Committee, and when approved by the Business Committee shall be considered adopted by this committee. Carried.

Mr. Holden moved that the building now called the Administration Building be used at the next fair for the Agricultural Department, and that the Business Committee arrange for other quarters for offices at their discretion. Carried.

The election of a general superintendent was taken up.

On motion of Mr. Stevenson, Mr. A. J. Doherty was elected by acclamation.

On motion the Secretary was instructed to cast the ballot of the committee for L. W. Snell as member of the Business Committee. Ballot so cast and Mr. Snell declared elected.

A recess was taken to meet at the Agricultural College at 3 o'clock p. m.

Agricultural College, Tuesday, January 12, 3 o'clock p. m.

Executive Committee met in the Mechanical Engineering building.

Called to order by the President.

On motion the title heretofore given to the position of business manager was changed to that of assistant general superintendent.

On motion of Mr. Tyler the general superintendent was authorized to appoint an assistant at a salary to be approved by the Business Committee.

On motion a committee of three—Messrs. Stevenson, Tyler, and Fifield—was appointed to recommend amount of salaries of officers for the ensuing year.

A recess was taken for five minutes. After recess the committee to recommend amount of salaries for officers reported, recommending the following schedule:

General superintendent and chairman of Business Committee, $500.

Other member of Business Committee, $100.

Secretary $1,200, Treasurer $400.

On motion the report was accepted and adopted.

BONDS OF OFFICERS.

On motion of Mr. Stevenson the bond of the Secretary was made $2,000, of the Treasurer $5,000, and such other amount as the Business Committee may require, and of the general superintendent $5,000, and that the fees for bonds be paid by the Society. All bonds to be approved by the President and kept on file in his office.

On motion of Mr. Stevenson the Business Committee was authorized to sell admission tickets at advance sale and to fix the price for advance sale, children's and evening admission tickets.

Mr. Fifield moved that the Business Committee be instructed not to enter into contract for any concession beyond the present year without the consent or approval of the Executive Committee. Carried.

The president announced the appointment of standing committees and executive superintendents as follows:

Business Committee—A. J. Doherty, L. W. Snell, I. H. Butterfield.

Finance Committee—D. D. Aitken, Eugene Fifield, T. F. Marston.

Rules and By-laws—W. J. Galbraith, N. J. Whelan, V. V. Green.

Premium List—Eugene Fifield, C. A. Tyler, D. D. Aitken, A. E. Stevenson, L. R. Taft, W. J. Terney, I. H. Butterfield.

Reception Committee—John T. Rich, L. C. Holden, George B. Horton.

The Program Committee, under the by-laws, is: The President, chief marshal and the business committee.

Special Committee on Legislation and Revision of the Constitution—W. J. Galbraith, Eugene Fifield, D. D. Aitken.

EXECUTIVE SUPERINTENDENTS.

Cattle—C. A. Tyler. Assistant, F. J. Lessiter.
Horses—L. W. Watkins.
Speed—Eugene Fifield.
Sheep—W. E. Boyden.
Swine—Geo. Kelly.
Poultry—L. C. Holden.
Agriculture—W. J. Terney.
Dairy—L. W. Snell.
Apiary—F. B. Ransford.
Main Building—Wm. Dawson.
Implements and Machinery—V. V. Green.
Vehicles—Chas. L. Edwards.
Art—Prof. A. H. Griffith.
Needlework—Mrs. Belle F. Clark.
Horticulture—L. R. Taft.
Educational—Thos. M. Sattler.
Chief Marshal and Superintendent of Police—A. J. Peek.
Concessions—The Business Committee.
Transportation—A. E. Stevenson.

On motion the appointments were approval and confirmed.

The question of providing space for the Canadian Government exhibit was brought up for discussion, and the prevailing sentiment was that space should be provided for that exhibit.

Mr. Doherty as general superintendent expressed his thanks to Mr. Slocum for his work as business manager, and to all officers and superintendents for their interest and cooperation in the work of the year.

On motion, adjourned.

I. H. BUTTERFIELD, Secretary.

REPORT OF THE MICHIGAN STATE ASSOCIATION OF FARMERS' CLUBS FOR THE YEAR ENDING JUNE 30, 1909.

The sixteenth annual meeting was held in Lansing, December 8th and 9th, 1908.

There were 62 clubs represented with 89 delegates. The meeting was full of interest throughout. The following papers and addresses were given:

"What Might be Expected of the Young Man of Today," C. B. Scully, Berlin and Almont F. C.

"Teaching Agriculture in the Rural School," Prof. W. H. French, M. A. C.

"Deep Waterway from the Great Lakes to the Atlantic," Robt. Gibbons, Detroit.

"Hired Help on the Farm," Mrs. C. P. Johnson, Hadley and Elba F. C.

"Cooperative Farming," Helmer Rabild, Washington, D. C.

"The Doctrine of Publicity and its Application to the Farmers' Clubs," Hon. I. R. Waterbury, Editor of Michigan Farmer.

"Farm Valuations from the Standpoint, Assessment," James McBride, Burton.

The report of the Associational Secretary showed an active list of 125 clubs in 31 counties with 7,000 members.

The clubs are accomplishing much good in every county where there is one organized and it is to be regretted that every county in the state has not a good live Farmers' Club.

In 1908, there were 817 meetings held with an average attendance of fifty.

Sixteen clubs have yearly programs.

Thirty-seven clubs have an annual picnic.

Seventeen clubs held fairs.

Twenty-one clubs held a temperance meeting.

Forty-one clubs reported through the Michigan Farmer.

The officers elected for 1909 are as follows:
President—A. L. Chandler, Owosso.
Vice President—Mrs. Clara L. French, Pompeii.
Secretary—Mrs. W. L. Cheney, Mason.
Treasurer—D. K. Hanna, Caro, R. 4.
Cor. Secretary—Clayton Cook, Owosso.

Directors:
D. M. Beckwith, Howell, 1909.
D. M. Garner, Davisburg, 1909.
T. B. Halladay, Norvell, 1910.
E. C. Hallock, Almont, 1910.
B. A. Holden, Wixom, 1911.
Wm. A. Marks, Fair Haven, 1911.

MRS. W. L. CHENEY,
Associational Secretary.

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